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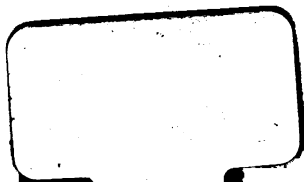
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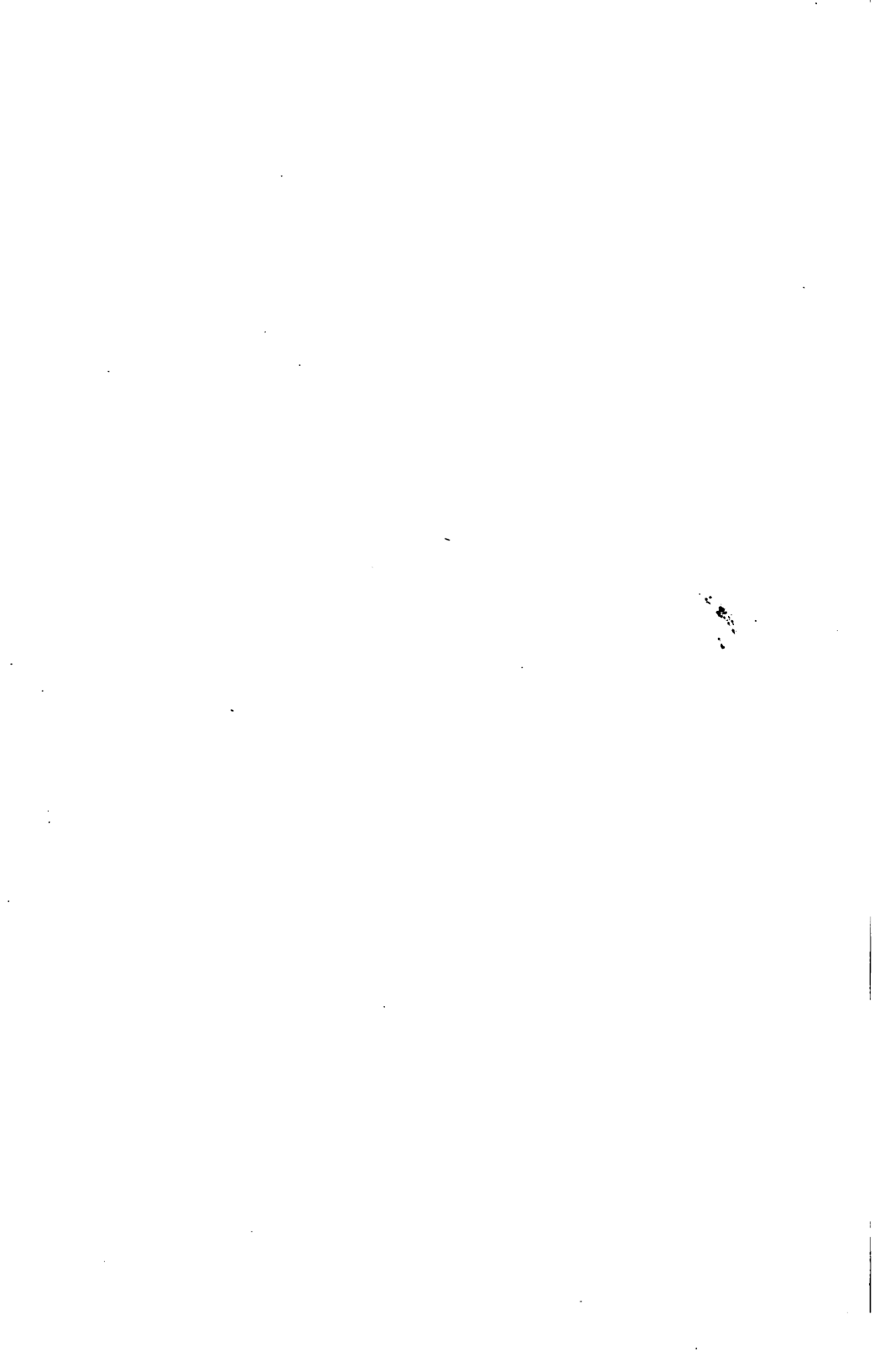
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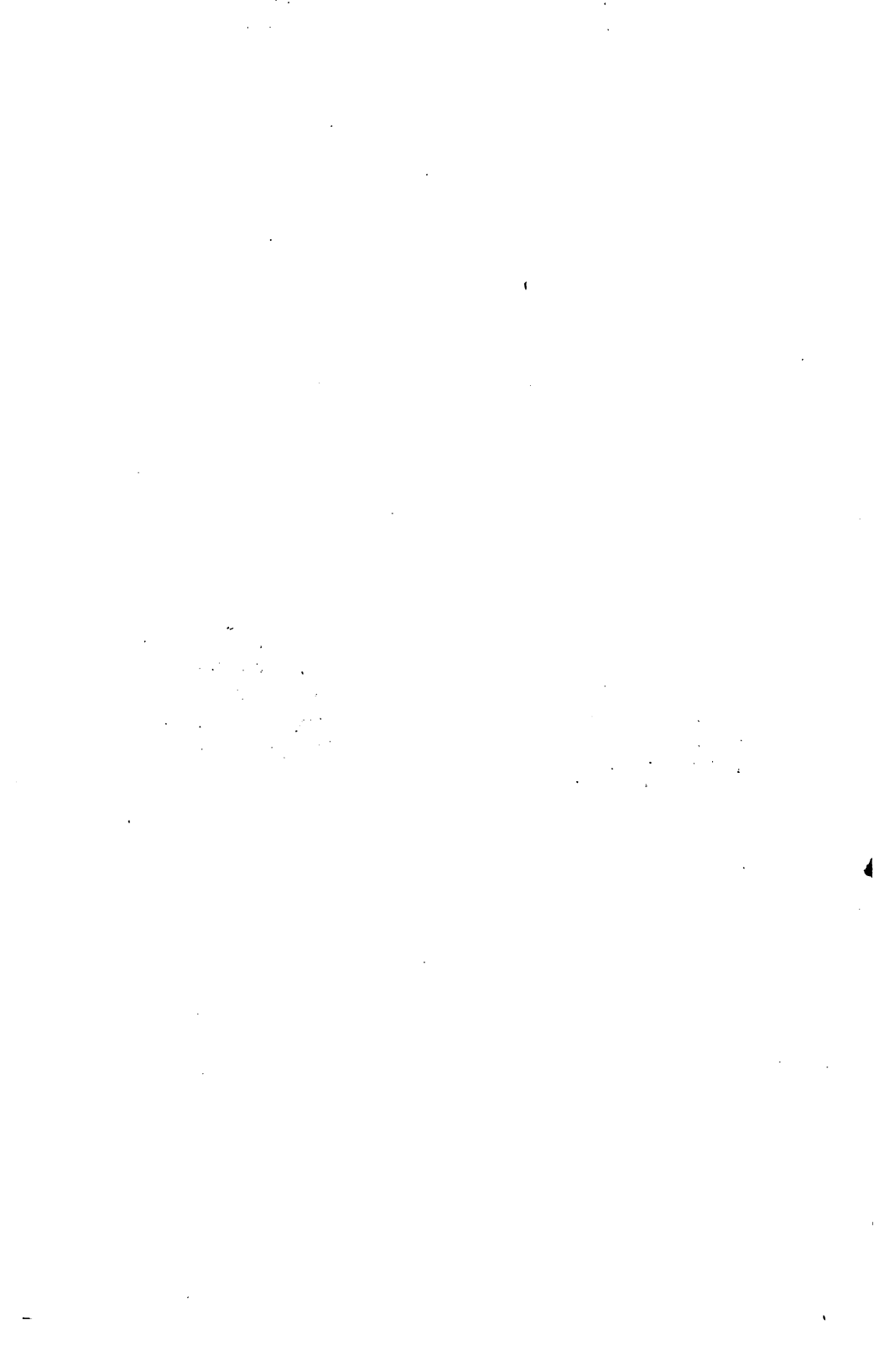
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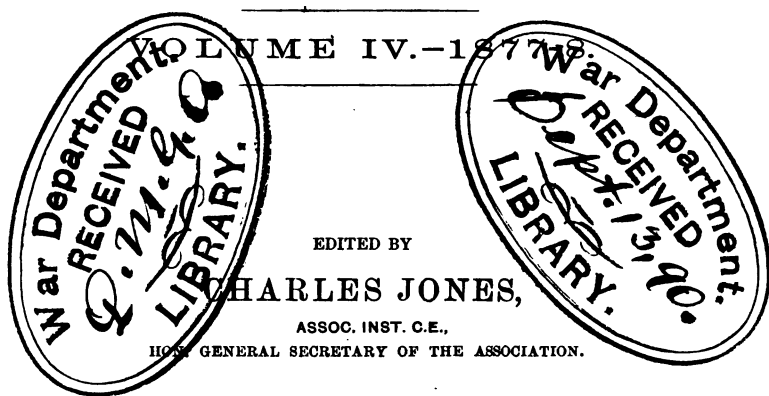




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OF THE

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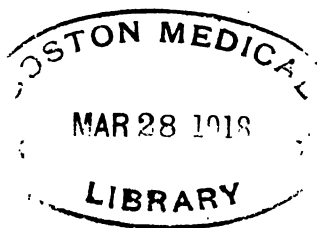
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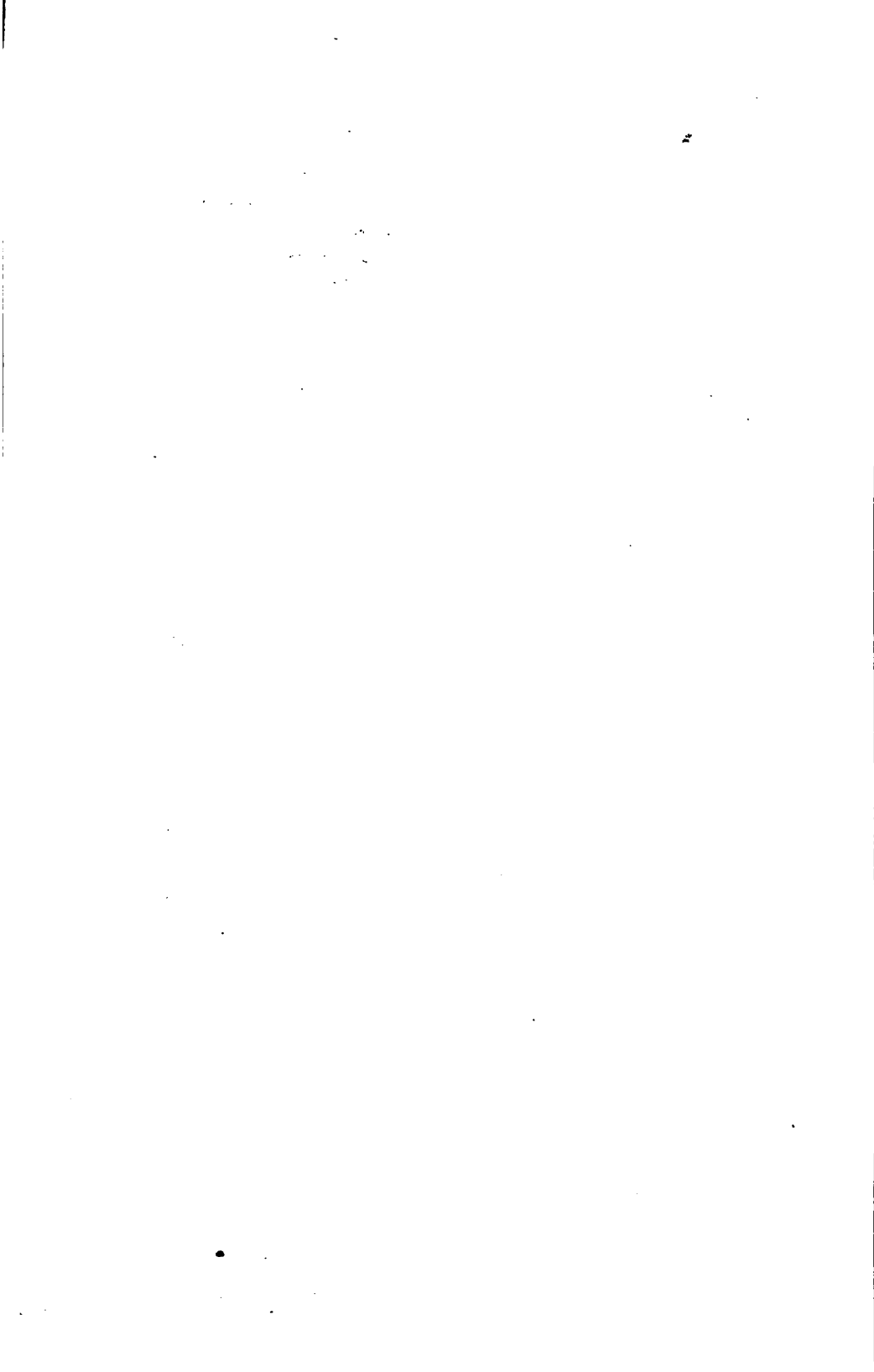
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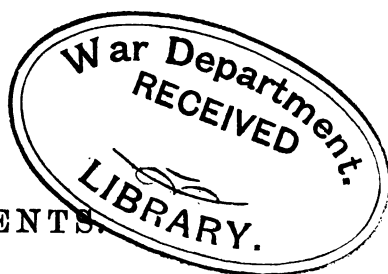
PREFACE.

IN presenting the following pages to our fellow Members, as well as to the general public, we cannot but call attention to the increased importance of the papers written, and the immense amount of valuable sanitary work of which they are the evidence. A few years since, the subject of Sanitary Science was one well-nigh ignored, or only looked upon as a matter to be treated by the scientific few; now how different, the noblest seats of learning and the humblest village schools alike recognise the necessity of the times, and class Sanitary Science as one of the most important of their studies; and in the recognition of this fact will be seen the extent of the work achieved by the "Association" from whence these papers emanate, and the value of the information given—not the fancies of mere theorists, but the practical experience of men who are daily and hourly in the discharge of their official duties gathering the information herein detailed, and thus adding their quota, through the pages of these "Proceedings," to the important subject of Sanitary Science.

C. J.

LOCAL BOARD OFFICE, EALING, W.





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CONGLETON	W. Blackshaw.
COVENTRY	E. J. Purnell (<i>Member of Council</i>).
CREWE	G. Watson.
CROYDON	T. Walker.
DALTON	W. H. Fox.
DERBY	C. Dunscombe (<i>Member of Council</i>).

DEWSBURY	B. C. Cross.
DUKINFIELD	W. Gill.
EALING	C. Jones (<i>Hon. Sec.</i>).
EPSOM	J. R. Harding.
ETON	J. Whitehouse.
EXETER	H. P. Boulnois (<i>Member of Council</i>).
FAREHAM	J. Rosevear.
FOLKESTONE	W. E. Springall.
GOOLE, YORKSHIRE	E. C. B. Tudor.
GRANTHAM, LINCOLNSHIRE	S. G. Gamble.
GREAT GRIMSBY	J. Maughan.
HALIFAX	E. R. S. Escott.
HANDSWORTH, STAFFORDSHIRE	E. Kenworthy.
HANLEY	J. Lobley.
HARBORNE	W. Newey.
HARROGATE, W. R. YORKSHIRE	E. W. Harry.
HARROW	F. N. Cowell.
HARWICH	H. Ditcham.
HEREFORD	G. Cole.
HIGH WYCOMBE	F. W. Burnham.
HORNSEY	J. R. Rogers.
HOVE	E. B. Ellice-Clark (<i>Member of Council</i>).
HULL	J. Fox Sharp (<i>Member of Council</i>).
HYDE	J. Mitchell.
IPSWICH	E. Buckham.
KENDAL	J. Banks.
KIDDERMINSTER	A. Comber.
LANCASTER	J. Hartley.
LEEDS	A. W. Morant (<i>Vice-President</i>).
LEEK	T. Frost.
LEICESTER	E. L. Stephens (<i>Member of Council</i>).
LEIGH, LANCASHIRE	G. Dickenson.
LITTLEBOROUGH	F. H. Shuttleworth.
LIVERPOOL	G. F. Deacon (<i>Vice-President</i>).
LLANDUDNO	T. T. Marks.
LONGTON	A. Hardwicke.
LOWESTOFT	R. H. Inch.
MAOCCLESFIELD	Jabez Wright.
MAIDENHEAD	E. Davey.
MAIDSTONE	J. S. Anscombe.
MALVERN	J. E. Palmer.
MANCHESTER	J. G. Lynde (<i>Past President</i>).
MEETHYR TYDFIL	S. Harpur (<i>Member of Council</i>).
MIDDLESBROUGH	E. D. Latham.
MILVERTON	G. F. Smith.
NEWBURY	B. Sargent.
NEWCASTLE-UPON-TYNE	A. M. Fowler (<i>Member of Council</i>).
NEWCASTLE-UNDER-LYME	J. T. Eayts.
NEWTON-IN-MAKERFIELD	R. Brierly.
NORTHAMPTON	J. H. Pidcock.

OLDBURY	J. Devis.
OSWESTRY	E. B. Smith.
OXFORD	W. H. White.
PENRHYN	G. G. Powell.
PLYMOUTH	R. Hodge.
PONTEFRAC T	W. Scriven.
PORTSMOUTH	J. E. Grestorex (<i>Member of Council</i>).
PRESOOT	W. Goldsworth.
PRESTWICH	S. C. Trapp.
READING	A. W. Parry.
REDDITCH	T. W. Baylis.
REIGATE	J. H. C. B. Hornibrook.
ROCHDALE	T. Hewson.
RYDE	T. Newman.
SALE	A. G. McBeath.
SCARBOROUGH	J. Petch.
SHEERNESS	H. S. Pollard.
SHEFFIELD	R. Davidson.
SHILDON AND EAST THICKLEY	J. Craggs.
SHREWSBURY	G. J. Butler.
SOUTHAMPTON	J. Lemon (<i>Past President</i>).
SOUTHPOET	W. Crabtree.
SOUTH SHIELDS	M. Hall.
SOWERBY BRIDGE	J. H. Smethurst.
STOCKTON-ON-TEES	J. Hall.
STOKE-ON-TRENT	C. Lynam (<i>Late Borough Surveyor</i>).
STOW-ON-THE-WOLD	B. H. Valle.
STRATFORD-ON-AVON	T. T. Allen.
STREETFORD	H. Royle.
ST. GEORGE, GLOUCESTERSHIRE	W. Dawson.
SUNDERLAND	C. Thwaites.
TAUNTON	J. H. Smith.
TEDDINGTON	T. Goodchild.
TEWKESBURY, GLOUCESTERSHIRE	W. H. Gray.
TIPTON, STAFFORDSHIRE	W. Jepson.
TONBRIDGE	W. Noot.
TORQUAY	J. Little.
TOWN MALLING	F. Y. G. May.
TOXTETH PARK, LIVERPOOL	J. A. Hall.
TRANMERE	W. A. Richardson.
TWICKENHAM	H. M. Ramsay.
TYNEMOUTH	J. P. Spencer.
VENTNOR	J. G. Livesay (<i>Late Town Surveyor</i>).
WAKEFIELD	J. Pagan.
WALLASEY	J. T. Lea.
WALSALL	W. J. Boys.
WANSTEAD	J. T. Bressey.
WARMINSTER	T. Cruse.
WARRINGTON	T. Longdin.
WARWICK	E. Pritchard (<i>Vice-President</i>).
WATERLOO, LIVERPOOL	R. Thompson (<i>Late Borough Surveyor</i>).
WATFORD	C. C. Lovejoy.

WATH-UPON-DEARNE	S. Rodgers.
WEDNESBURY	J. W. Fereday.
WELLINGBOROUGH	E. Sharman.
WEST BROMWICH, STAFFORDSHIRE ..	T. R. Lofthouse.
WEST DERBY, LIVERPOOL	E. H. Allies.
WEST HAM, LONDON	L. Angell (<i>Past President</i>).
WEYMOUTH AND MELCOMBE REGIS ..	W. B. Morgan.
WILLENHALL	B. Baker.
WILLESDEN	O. C. Robson.
WOLVERHAMPTON	G. E. Thoms.
WORTHING	J. Lund.
WREXHAM	J. W. M. Smith.

RULES OF THE ASSOCIATION.

I.—That the Society be named the “ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS.”

II.—That the objects of the Association be—

- a. The promotion and interchange among its Members of that species of knowledge and practice which falls within the department of an Engineer or Surveyor engaged in the discharge of the duties imposed by the Public Health, Local Government, and other Sanitary Acts.
- b. The promotion of the professional interests of the Members.
- c. The general promotion of the objects of Sanitary Science.

III.—That the Association consist of Civil Engineers and Surveyors holding permanent appointments under the various Municipal and Sanitary Authorities within the control of the Local Government Board, and such Honorary Members as shall be elected by the Council. Members who retire from their official position are eligible for re-election by the Council.

IV.—That the Affairs of the Association be governed by a Council, consisting of a President, Three Vice-Presidents, Twelve Members, and a Honorary Secretary, to be elected annually. The Past Presidents and the District Secretaries for the time being shall also be Members of the Council.

V.—That the Council shall nominate one name for President, six for Vice-Presidents, one for Secretary, and twenty-two Ordinary Members from whom to elect the Council. Such Nominations shall be printed and sent to each Member of the Association not less than thirty days previous to the Annual Meeting. Every Member shall be entitled to vote for or erase any of such Nominations, or substitute other names, subject in all cases to the limits of Rule IV., and return the same within seven days of the date of issue, and the Members who shall obtain a majority of votes shall respectively be duly elected President, Vice-Presidents, Members of Council, and Honorary Secretary for the ensuing year.

- VI. That the Association be formed into District Committees which shall include the whole of the Members. Such Committees shall meet from time to time, in convenient centres, for the discussion of matters of local and general interest connected with the Association. Each District Committee shall appoint a Local Secretary, who will keep records of local proceedings, and communicate with the Council. No District Committee or Local Secretary shall be entitled either to represent or act on behalf of the Association.
- VII. That a General Meeting and Conference of the Association shall be held annually in such towns, in rotation, as may afford convenient centres for assembling the Members.
- VIII. That an entrance-fee of One Guinea, and a subscription of One Guinea per annum, from Civil Engineers and Surveyors under Rule III., shall constitute Membership of the Association.

SUBSCRIPTION ACCOUNT.

	£	s.	d.		£	s.	d.
Arrears from last year	..	..	..	Received for Arrears	..	..	..
Subscriptions due for current year	..	..	..	" Subscriptions	..	..	..
Admission fees .. .. .	..	..	..	" Admission Fees	..	..	..
	..	..	..	Written off for Members deceased and disqualified	..	..	..
	..	..	..	being the accumulation from the commencement	..	..	..
	..	..	..	of the Association	..	..	..
	..	..	..	Balance—Arrears due	..	..	..
	£280	7	0				£280 7 0

CASH ACCOUNT.

RECEIPTS.				EXPENDITURE.			
	£	s.	d.		£	s.	d.
Balance from last year	..	..	..	Home Counties District	..	..	..
Arrear Subscriptions	..	..	..	Midland Counties District	..	..	..
Current .. .. .	..	..	..	Lancashire and Cheshire District	..	..	..
Admission Fees .. .. .	..	..	..	General Expenses—	..	..	..
Sale of Proceedings .. .. .	..	..	..	Printing and Stationery	..	..	..
Balance carried forward	..	..	..	Advertisements	..	..	..
	..	..	..	Expenses at London Meeting, ..	..	..	..
	..	..	..	Reporting at ditto	..	..	..
	..	..	..	Printing Proceedings (estimated)	..	..	..
	..	..	..	Stamps	..	..	..
	..	..	..	Secretarial Expenses	..	..	..
	..	..	..	Petty Cash Sundries	..	..	..
	£167	12	0				£167 12 0

I have examined the above Accounts and compared them with the vouchers and receipts, and certify them to be correct, and that the amount of indebtedness of the Association at the close of the Subscription year 1877 is £4 8s., and that the amount of the arrears due is £109 4s.

2nd July, 1878.

(Signed) ALBERT W. PARRY, Auditor.

ADVERTISEMENT.



THE Association is not responsible for the statements or opinions advanced in the Papers and Discussions contained in the following pages.

War Department Library

ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS.

POSTAL
MAR 28 1918
FOURTH ANNUAL MEETING,
LIBRARY
July 19th and 20th, 1877,

HELD AT THE OFFICES OF THE SANITARY AUTHORITY, BRISTOL.

THE Members of the Association assembled at 12.30 in the Board Room of the Sanitary Authority, Bristol.

MR. JAMES LEMON, M. Inst. C.E., of Southampton, President of the Association, in the chair.

THE PRESIDENT, having expressed his personal satisfaction at again meeting the Members of the Association, and having congratulated them upon the success of the Association, called upon the Hon. Sec., Mr. Charles Jones, of Ealing, to read the Annual Report of the Council.

To the Members of the Association of Municipal and Sanitary Engineers and Surveyors.

REPORT OF THE PRESIDENT AND COUNCIL FOR THE YEAR 1876-7.

GENTLEMEN,—The President and Council of the past year have much pleasure in meeting their fellow Members in the ancient City of Bristol, and in resigning into their hands the official positions to which they had the honour of being appointed at the last Annual Meeting, held in July, 1876.

Your Council regret that from causes over which they had no control the District Meetings have not been so frequent as could be desired. The removal of the Home District Secretary, Mr. Ellice-Clark, from Ramsgate to Derby, was, as may readily be supposed, an unfortunate circumstance, as it was impossible to find a gentleman at once to form so earnest and energetic a centre for the

Home District to rally around ; the difficulty is, however, now surmounted by the return of Mr. Clark to the Home District, and the promptness with which he has got to work, having already commenced, in conjunction with Mr. Buckham, of Ipswich, operations in the Eastern Counties.

In the Yorkshire District a similar circumstance has occurred. Mr. Alty having resigned his position at Keighley for the Town Surveyorship of Barrow-in-Furness, found it impossible to work the District during the year ; this, we are happy to say, has been remedied likewise, for at our Meeting convened at Halifax on the 13th of the present month, when, Mr. Alty having resigned, Mr. B. C. Cross, of Dewsbury, was appointed Secretary, and in communicating with the Hon. Sec. upon the subject, states as follows :—
“ We are about to have a strong effort to get some good meetings up here, and I believe that if properly worked we shall succeed.”

Although during the past year the District Meetings have been less frequent, the Council do not feel that it in any degree evinces a decline in interest in the Association work, the long distances many of our Members have to travel, and the desire not to multiply times of absence from official work, will well account for any apparent difference in the work of the year over the preceding, and you have reason to look forward to the current year as one probably of considerable success.

The intimation which the Members received some few weeks since with respect to the publication of Proceedings will, we believe, be generally acceptable to the Members and add to the interest of all concerned. Members will obtain the various papers within a month of the time of delivery, instead of waiting some twelve months as at present, the experience of the past year proving beyond a doubt the importance of such an arrangement ; and the Council cannot but feel that the work already done has been a trespass upon the time of our valued friend, Lewis Angell, Esq., which should not longer be permitted to exist. The number of Members at present associated with us is nearly 200, and new Members are coming in.

The Council recommend that the Annual Meeting for 1878 should be held at Liverpool.

The result of the ballots for office for the year 1877-8 is as follows :—

President.—Frederick Ashmead, M. Inst. C.E., Bristol.

Vice-Presidents.—G. F. Deacon, M. Inst. C.E., Liverpool ; A. W.

Morant, Assoc. Inst. C.E., Leeds ; E. Pritchard, Assoc. Inst. C.E., Warwick.

Members.—P. B. Coghlan, C.E., Sheffield ; C. A. Dunscombe, C.E., M.A., Derby ; E. B. Ellice-Clark, Assoc. Inst. C.E., Hove ; A. M. Fowler, M. Inst. C.E., Salford ; J. E. Greatorex, C.E., Portsmouth ; S. Harpur, Assoc. Inst. C.E., Merthyr Tydvil ; P. C. Lockwood, Assoc. Inst. C.E., Brighton ; E. J. Purnell, C.E., Coventry ; J. Fox Sharp, Assoc. Inst. C.E., Hull ; E. L. Stephens, C.E., Leicester ; T. C. Thorburn, C.E., Birkenhead ; W. S. Till, C.E., Birmingham.

Past Presidents.—L. Angell, M. Inst. C.E., F.R.I.B.A., Stratford, E. ; J. Lemon, Assoc. Inst. C.E., Southampton ; J. G. Lynde, M. Inst. C.E., Manchester.

Auditor.—A. W. Parry, Assoc. Inst. C.E., Reading.

District Secretaries.—B. C. Cross, C.E., Yorkshire District ; E. B. Ellice-Clark, Assoc. Inst. C.E., Home Counties District ; E. Pritchard, Assoc. Inst. C.E., Midland Counties District ; R. Vawser, M. Inst. C.E., Lancashire and Cheshire Districts.

Honorary General Secretary.—C. Jones, Assoc. Inst. C.E., Ealing.

PRESIDENT'S ADDRESS.

GENTLEMEN,

Mr. Lewis Angell, on taking the Presidential Chair of this Association for the second time in 1874, expressed a wish that "Government would establish some standard method applicable to varying circumstances for the drainage of towns."

And during the present year one of the most, if not *the* most, important report issued by the Local Government Board, has been the Report by Mr. Robert Rawlinson, C.B., C.E., and Mr. Clare S. Read, M.P., with Mr. S. J. Smith, on "The Several Modes of Treating Town Sewage." The conclusions arrived at being very much in accord with those already propounded by the Members of this Association—notably as regards the question of the non-productive manipulation of sewage by any known process.

The condemnation of the dry-earth or pail systems, although not so generally admitted, is quite in unison with my own views, and also that the best and cheapest mode of dealing with the sewage of towns is by discharging it into the sea.

It is also satisfactory to have the opinion of so high an authority as to the working of Captain Liernur's pneumatic system, viz. that it is not adapted for our English towns.

In Mr. Angell's first Presidential Address in 1873, he mentioned as one of the greatest difficulties the Sanitary Engineer had to contend with was to induce people to appreciate sanitary principles, but the question of house drainage and sewage of towns has now received a considerable amount of attention, and during the past year, especially under the auspices of the Society of Arts, at whose rooms in London a conference of the Sanitary Engineers of the country was held on the 9th and 10th of May, 1876, when the several modes of dealing with sewage and matters connected with its disposal were discussed, and the following conclusions arrived at by the Executive Committee, viz. :

That a sewage farm properly conducted is apparently the best method of disposing of water-carried sewage ;

That by precipitation or filtration a sufficiently purified effluent

can be produced for discharge without injurious results into water-courses or rivers, but that the sludge in a manurial point of view is of low and uncertain commercial value, and that means must be used for getting rid of it without reference to possible profit.

In towns where a water-carriage system is employed, thorough ventilation, a proper connection of the house drains and pipes with the sewers, and their arrangement and maintenance in an efficient condition, are absolutely essential.

With regard to the various dry systems, where collection at short intervals is properly carried out, the result appears to be satisfactory, but no profitable application of any one of them appears as yet to have been accomplished.

It was conclusively shown that no one system for disposing of sewage could be adopted for universal use, but for health's sake, without consideration of commercial profit, sewage and excreta must be got rid of at any cost.

The resolutions submitted as the basis of petitions to Parliament by the Executive Committee have been in force in this city since May, 1871, viz., that plans and sections of all drains are to be deposited at the offices of the Authority, and all new houses before being occupied are required to be certified by the City Surveyor as having been completed in accordance with the Bye-laws.

Also in November last, a paper was read at the rooms of the Society of Arts by Major-General F. C. Cotton, C.S.I., on house drainage.

Another paper was read before the Liverpool Architectural Society, in the same month, by Mr. T. Mellard Reade, C.E., on how to drain a house.

And an architect of this city, Mr. Henry Masters, has published a letter on sewer gas and house drainage; how to keep out the former, and how to construct and ventilate the latter, viz., by producing a constant current of air in the drains by means of two air-pipes, east and west of the house, and having the drain connecting with the sewer doubly trapped.

The President of the New York Board of Health for the year 1873, states that house drains should at all times be air and water tight, and have ample ventilation; that ventilating pipes to be effective should be as near as possible the diameter of the pipes intended to be ventilated, and never less than one-half of such diameter, and should be carried at least 2 feet above the roof of the house.

The question of ventilation of sewers and drains having been so frequently discussed, I do not propose introducing the subject here, except to say that Bristol stands almost alone in this matter ; its sewers having been working successfully for upwards of twenty years without ventilation. Of late years some of the house drains have been ventilated, and all communication with the main sewers cut off in a somewhat similar manner to that proposed by Mr. Masters ; and I hold if this is properly done the necessity for ventilating the main sewers does not exist, unless it be to allow men to enter them for cleansing or other purposes ; and I am of opinion that if the original construction of the sewers is effectual and the water supply is ample, such cleansing is rendered unnecessary, and *consequently* ventilation ; but an opportunity will be afforded at this Meeting of hearing the opinions and experience of the several Members now present on the reading of a paper describing the sewers of the city.

We have also a Sanitary Institute of Great Britain, meeting in Spring Gardens, presided over by the Duke of Northumberland, all tending to show that the question of sanitary reform is considered of much more importance now than formerly.

The question as to the apportionment of the costs of improvement expenses in private streets has undergone some alteration during the past year, more especially as regards the ownership of side streets, or the ends of streets abutting on private property, under 38 and 39 Vict., chap. 55, P. H. Act, 1875, sec. 150. As to ownership of side streets, see "*Pound and Northbrook v. Plumstead Board of Works*," which holds that the owner of streets laid out on private land is owner of lands liable to pay proportion of costs of paving, &c., &c.

And "*Plumstead Board of Works v. British Land Company*" confirms this by declaring the owners of land laid out for building are owners of streets set out for the same, and thrown open to the public, and as such liable for the proportion of streets on which they abut (that is, at intersections or cross streets). This case was, however, appealed against in the Exchequer Chamber, when the decision of the Queen's Bench was reversed, and it was held that the owner of land laid out for building was not, within the meaning of the Act, an owner of land in respect of ground laid out as roads and dedicated to the public, and was not liable to pay proportion of cost of paving, &c., new streets on which such other streets abut.

It may not be generally known, but for several years past at my recommendation the Bristol Authority have charged the several owners 5 per cent. on the outlay for superintendence of works in private streets, which amount goes to the credit of payment for salaries.

The Bill for the Prevention of the Pollution of Rivers, 1876, has now become law, and the Inspectors appointed for carrying out its provisions are Mr. Robert Rawlinson, C.B. and C.E., and Dr. Robert Angus Smith, F.R.S., but I have not as yet heard of any action having been taken under the same.

Several District meetings have been held during the year, as has already been reported.

These meetings, I hold, are very important to the well-being of the Association; they have not been quite so numerous as in former years, but I hope we shall after this Annual Meeting do better in this part of the country, and form a district for the western counties during my year of office.

The question as to the best material for carriage-way pavements continues to receive a considerable amount of attention; my own opinion is still the same as expressed at the last General Meeting in London, viz., that for cleanliness and comfort, wood paving is the best, and so far as my experience goes, I prefer the asphaltic; but having had the ends of the wood blocks laid close together the expansion of the wood during wet weather has forced upwards the paving of the footways on either side of the roadway to such an extent as to necessitate relaying. And for durability I am still of opinion that granite sets laid in pitch and tar is most advantageous in all respects.

Up to within the last three years, we have in Bristol been content to use the local limestone for our macadam roads and streets, but we have now introduced granite, greenstone, millstone grit, and other materials for some of our streets of great traffic, and after eighteen or twenty-four months' trial I am inclined to give the preference to a greenstone obtained from Penzance, as making the best road under all circumstances.

The best material for footpaths depends somewhat upon locality, as, for example, we have near this city a local stone known as "pennant," which is found near the coal-measures; this can be furnished at a price lower than any other material of equal durability, its average life being about twenty years; we do not therefore use any other material for our principal thoroughfares, but for

our suburban paths we use instead of gravel a gas-tar paving, which lasts from six to eight years, according to the traffic.

Tramways have now been introduced into this city, and have so far proved a complete success and a great convenience to the general public, although the public using their own carriages complain of the interference with the comfort of the roads through which the tram-cars pass.

The mode of laying adopted, after much consideration, is that known as "Kincard's" patent, viz. with iron chairs 3 feet apart and side fastenings. The lines are for the most part single, with sidings or passing places at frequent intervals; but I am inclined to think that as a rule it will be to the interest of all parties concerned if tramways in streets of ordinary width were laid double.

The greatest incline now worked in this city is at Colston Street, which has a gradient of 1 in 16, and requires four horses to draw one tram-car containing eighteen passengers inside and twenty outside.

The roadways inside the rails, and for 18 inches outside each rail, are in all cases pitched with granite sets.

The question of using power other than horse-power has been considered by a Committee of the House of Commons, but they have not yet sanctioned the use of steam power on tramways; the last successful trial of a street steam-tramway engine was, I understand, made at Belfast.

Again thanking you for the honour you have conferred upon me, I will conclude by asking your support and assistance in carrying out the duties of the office during the coming year.

REPORT ON THE DRAINAGE OF THE CITY AND COUNTY OF BRISTOL.

BY FREDERICK ASHMEAD, M. INST. C.E., ENGINEER AND
SURVEYOR TO THE SANITARY AUTHORITY.

THE Borough of Bristol extends over an area of 4687 acres, or nearly 8 square miles, containing a population at the last census, in 1871, of 182,524, with an estimated population at the present time of 202,950, and about 140 miles of streets and roads. The rateable value in April, 1877, was 772,623*l.*; number of houses in 1871, 27,536.

Before describing in detail the drainage of the Borough, it will be necessary to give a few particulars as to its position in relation to the rivers Avon and Frome, as until the commencement of the present century the tidal waters of these rivers flowed up the present Floating Harbour, underneath the Drawbridge, and up the river Frome on one branch, and up the Grove underneath Bristol Bridge on the other branch, as far as Hanham Mills, at which time they received the whole of the drainage of the districts through which they passed.

About the year 1803, the Bristol Docks Company was formed for the purpose of floating a portion of the river, by constructing dams, entrance basins, and locks, also making a new channel for the river Avon, under the direction of Mr. William Jessop, C.E.

On the 30th April, 1809, these works were set in operation, and the rivers Avon and Frome were dammed up, and the waters therein became stagnant. From that period to the year 1825 frequent complaints of the very disagreeable and unwholesome effluvia arising from the Frome (part of the Floating Harbour) were made to the Dock Company, and other public bodies. And on the 1st day of August, 1825, the Commissioners for paving, cleansing, and lighting the city (in whom the property of the common sewers was vested), in consequence of the then pernicious condition of the water in the Frome part of the harbour, appointed a Committee to inquire into the state of the sewers which emptied themselves

into that part of the Float, and to consider whether any and what remedy could be adopted whereby the sewage might be conveyed off without being deposited in the Floating Harbour.

In the course of the investigation pursued by this Committee, they ascertained that common sewers of about $5\frac{1}{2}$ miles in length emptied themselves into the Frome, and the Commissioners forwarded to the Dock Company a representation of the state of the Frome and the liability of the Company to apply a remedy.

This was eventually done by the Dock Company constructing the culvert known as Mylne's Culvert, the Bread Street culvert having been previously constructed by the Dock Company; the greater part of the sewage then discharging into the Floating Harbour was by these culverts diverted into the river Avon.

These culverts being important works connected with the drainage of the city, a short description of the same may not be considered out of place. The first, named "Mylne's Culvert," constructed by Mr. William Chadwell Mylne, M. Inst. C.E., F.R.S., and by whose name the culvert has since been known, commences at the stone bridge, 5 feet 6 inches high by 5 feet wide, passing in front of the Tontine warehouses along the Broad and Narrow Quays to near Prince Street Bridge, from whence it passes under the Floating Harbour for about 100 yards in cast-iron pipes, 3 feet 6 inches in diameter, forming a syphon or dip of 7 feet; these pipes are well and securely laid to the required angle by means of turned and bored ball and socket joints, and bolted together after being fixed in place; the culvert is then continued in a line parallel with the Prince Street Bridge Road, and discharged into the river Avon in front of the Gaol, the size at this part being an oval of 5 feet 6 inches by 5 feet, with a gradient of 1 in 247.

Bread Street Culvert commences near the Castle Mill at the bottom of Tower Hill, 3 feet 6 inches in diameter, passing along Bread Street and Avon Street, in front of the Gas Works, to the side of the feeder near the Marsh Bridge, continuing under the feeder in cast-iron pipes similar to the pipes described above for Mylne's Culvert, and formerly continued under Messrs. Hare's premises into the river, but it now continues along the road, and discharges into the river Avon, above Totterdown Lock, the size being 3 feet 6 inches high by 3 feet, having a gradient of 1 in 300.

These culverts with the existing sewers in the old city, and the new sewers constructed by the late surveyor to the Commissioners, Mr. John Armstrong, Associate Inst. C.E., making a length of

about 41 miles, completed the drainage of the old city at the time of the adoption of the Public Health Act.

This Act was, after considerable opposition by the then Commissioners, applied in 1851, and at the same time the outlying districts of Clifton, Westbury, St. Philip and Jacob, and the district of Bedminster were placed under one government, viz. the Corporation of the City and County of Bristol, acting as the Local Board of Health, since which time the management and control of the sewers of the whole district have been entrusted to a Committee of the Council elected annually.

One of the first acts of this Committee was to ascertain the state of the drainage of the whole borough, with a view to improving the same; and after considerable discussion as to the best means of accomplishing this object, it was decided to proceed with the drainage gradually and in districts, as the best and cheapest mode, this course being almost a necessity in consequence of the peculiarly isolated position of parts of the borough by reason of the rivers Avon and Frome, the Floating Harbour, locks, tidal basins, and other works naturally dividing the whole borough into districts. The levels and dimensions of the sewers being so designed and arranged as to form one continuous scheme to be eventually united so as to discharge the sewage of the whole borough at one or two points on each side of the river for deodorization or for continuing the same to the mouth of the river Avon, as may be hereafter determined.

And for drainage purposes, the borough has been divided into six districts, as follows: No. 1. Clifton High Level; No. 2. Bedminster; No. 3. Clifton Low Level; No. 4. St. Philip's; No. 5. The Frome; and No. 6. The Avon, intercepting. The districts most requiring attention being first undertaken.

1. CLIFTON HIGH LEVEL DISTRICT.—For drainage purposes Clifton has been divided into two districts, viz. the High and the Low Level Districts, and the first undertaken was the High Level District. It includes the whole of the higher parts of Clifton, and parts of Westbury and Cotham, coloured pink on the plan, and is drained by means of a main sewer commencing about 9 feet under the lowest part of Hampton Road, of the size 3 feet 6 inches high by 3 feet wide, with a gradient of 1 in 300, passing under White Ladies Road at a depth of 20 feet; it continues along Alma Road of the size of 4 feet by 3 feet 6 inches, and the same gradient of 1 in 300, to Pembroke Road, at which point it is about 42 feet

under the surface of the road at its lowest point; the sewer then continues under the College grounds at a depth of about 64 feet, until arriving at the Clifton Down Road at a depth of 74 feet with the same fall, and a size of 4 feet by 3 feet 6 inches; passing underneath Bridge Valley Road it arrives at the new zig-zag, at which point it is continued 4 feet in diameter, and passes down an incline of about 1 in 4 to the river Avon.

Main branch sewers are constructed along the several main roads of the district, viz. White Ladies Road, Redland Road, and Cotham Road, as shown in the plan and sections, which, with smaller size sewers, drain into the main sewer already described.

The area of this district is about 1041 acres. The length of new sewers about 11 miles, and the cost of same about 34,014*l*. The drainage of the district was commenced in June, 1855, and finished about July, 1857.

The money for the cost of the sewers in this district was borrowed of the Public Works Loan Commissioners, at 5 per cent., for a term of twenty years only, the principal and interest being raised each year; the whole sum has now been paid off, and consequently the sewer rate in this district will no longer be charged.

The rateable value of the district in 1855 was 75,200*l*., and in 1875 was 149,178*l*., the highest rate made for drainage purposes was 1*s*. in the pound, which was gradually reduced to 2*d*. in the pound, and, as before stated, is now paid off.

On submitting the plans of this first district for the approval of the Local Government Board in London, Mr. Austin, Superintending Inspector, was sent down to represent to the Committee the advisability of adopting small-size pipes instead of brick sewers; and the writer was directed to proceed to St. Thomas, near Exeter, Birmingham, and other places, and report on the drainage as there carried out: the result of such inquiry being the confirmation of the original report which was adopted by the Committee, and eventually the sanction of the Government was obtained, and the sewers have been constructed as originally designed. The results have fully confirmed the soundness of the decision then arrived at; the sewers having continued to work in a satisfactory manner to the present time without failure of any description or additional cost for cleansing, flushing, or repairs.

2. **BEDMINSTER DISTRICT.**—The next district taken was part of the parish of Bedminster, coloured green on the plan, and situate

on the south side of the river Avon, this being considered by the Committee the next most urgent.

It is drained by the main sewer commencing in East Street about 13 feet under the roadway, $4\frac{1}{2}$ feet by 4 feet in size; passing into Dean Lane at a depth of about 12 feet, it continues along the same and passes under Nelson Terrace and Coronation Road, at a depth of about 40 feet, and formerly discharged into the river Avon at that point, but has now been connected with the new sewer constructed for the Avon Sewer District, and carried down and discharged near Clift House; this district lying low and the outfall being closed for several hours during each tide, it was necessary to construct the main sewer of a larger size, viz. 6 feet by 5 feet 6 inches, as a containing sewer or reservoir, the gradient being 1 in 300.

Main branch sewers have also been constructed along North Street, East and West Streets, as shown on plan and sections, and with other smaller sewers complete the drainage of the district, and discharge into the main sewer already described.

A separate outfall sewer, called Parsons Street sewer, was also constructed for a portion of this district, lying on the extreme boundary of the borough, commencing at a depth of about 8 feet, and in size 2 feet 6 inches by 2 feet; continuing along Parsons Street it passes under the main road to Bedminster Down at a depth of about 33 feet, under some high ground near Bedminster House at a depth of about 46 feet into the low-lying district of Duckmoor, along which it continues, passing under the main road, to Ashton, and through the fields to the river Avon, discharging near Clift House, having a gradient of 1 in 300 feet.

The area of this district is about 607 acres, the length of sewers about $5\frac{1}{4}$ miles, the cost of same about 11,424*l*. The drainage of the district was commenced in October, 1855, and completed about July, 1858.

The money for the cost of the sewers in this district was obtained from the Public Works Loan Commissioners at 5 per cent., to be repaid in twenty years.

The rateable value of this district in 1856 was 20,767*l*., and in 1875, 39,736*l*.; the highest rate made for drainage purposes was 1*s*. 6*d*. in the pound, which has been gradually reduced to the rate of 5*d*. in the pound, and the whole is now paid off.

3. CLIFTON LOW LEVEL DISTRICT.—The next district undertaken was the Low Level District of Clifton; it includes the portion of Clifton not provided for in the High Level District of Clifton,

and is coloured yellow on the plan. The main sewer of this district may be called an intercepting sewer, as it passes in nearly a parallel line with the Floating Harbour and the river Avon; it is also constructed sufficiently large to receive the drainage from a portion of the Frome District, to be hereafter described.

It commences in Hotwell Road, at the bottom of Jacob's Wells, at a depth of 13 feet, and in size 3 feet 6 inches by 3 feet; it continues along the Hotwell Road and is provided with storm overflows into the Floating Harbour, and means for flushing the sewer from the Floating Harbour is also provided; continuing along the Hotwell Road it passes in front of Dowry Parade, St. Vincent's Parade, underneath the rocks to the towing-path in front of Point House to the outlet of the High Level Sewer District, at an average depth of about 22 feet and 4 feet 6 inches by 4 feet in size, with a gradient of 1 in 600.

The area of this district is about 279 acres, the length of new sewers about 3 miles, and the cost of same 13,969*l*. The construction of the sewers was commenced about June, 1858, and completed about July, 1859. The money for the same was also borrowed from the Public Works Loan Commissioners for twenty years at 5 per cent. in 1858, at which time the rateable value of the district was 50,315*l*., and the present value is 72,970*l*. The highest rate made for drainage purposes was 9*d*. in the pound, and the present rate is 3*d*. in the pound; the whole amount borrowed will be paid off in 1878.

4. ST. PHILIP'S DISTRICT.—This district is situate on the east side of the borough, and is bounded on the north by the river Frome, on the west and south by the Floating Harbour, and on the east by the boundary of the borough, and is coloured blue on the plan. This district was partially drained by the Bread Street culvert already described, but a new main sewer has been constructed, commencing at Baptist Mills and continuing along the south side of the river Frome, so as to intercept all drains discharging into the said river so far as Haberfield Street, up which it passes, and continues along Captain Carey's Lane and underneath Old Market Street at a depth of 32 feet 6 inches, and in size 3 feet 6 inches by 3 feet, with a gradient of 1 in 500. It then continues along under John Street, St. Philip's Plain, Bread Street, and into Cheese Lane, along which it passes, continuing along Avon Street to the Feeder near Marsh Bridge, under which it passes in cast-iron pipes before described for Bread Street culvert; it then continues along the Feeder Road and discharges into the river Avon

above Totterdown Lock, having a gradient of 1 in 500. This sewer with smaller branches completes the drainage of the district.

The area of this district is about 685 acres, the length of new sewers about seven miles, and the cost of same about 25,121*l*. The drainage of the district was commenced about August, 1858, and completed about November, 1861. The money for this district was also borrowed from the Public Works Loan Commissioners for twenty years at 5 per cent.

The rateable value of the district in 1858 was 67,151*l*. and the present value is 127,277*l*.; the highest rate made for drainage purposes in this district was 10*d*. in the pound, and the present rate is 2*d*. in the pound; the whole of the money borrowed will be paid off in 1878.

5. FROME INTERCEPTING SEWER DISTRICT.—This district lies on the north side of the river Frome, which river formerly received the drainage of the district, and is coloured brown on the plan.

This district has been divided into separate areas, and is now drained by means of two main sewers, one for the higher ground, and the other for the lower level. The first-named commences at the boundary of the borough in Stokes Croft Road, at which point it receives the drainage of Horfield Parish, lying outside the boundary of the borough (the said parish having paid the Sanitary Authority the sum of 410*l*. for such use, and entered into an arrangement to pay *pro rata* any additional cost the Authority may hereafter incur by deodorization or other expense), passing along Stokes Croft Road at a depth of 10 feet, of the size of 3 feet by 2 feet 6 inches, with a gradient of 1 in 201·5; it continues along Jamaica Street in front of the Infirmary along Upper Maudlin Street, at a depth of about 28 feet, into Trenchard Street to the bottom of Lodge Street, at which point there is an incline of 1 in 19 into Frogmore Street, passing the bottom of Park Street at a depth of 18 feet; it continues along College Street, passing the back of the gas-works at Canons Marsh, and discharges into the main sewer for the low level district of Clifton, before described, and into the tidal river.

The low level main sewer commences at Baptist Mills, on the north side of the river Frome, and passes under Ashley Road at a depth of about 10 feet, and in size 3 feet 6 inches by 3 feet, and continuing underneath the new road into Newfoundland Road, along which it passes at a depth of about 17 feet, and in size 4 feet by 3 feet 6 inches, with a gradient of 1 in 600, into Milk Street, at

which place during the construction a large quantity of water was met with, and it was feared that the water supply of the district would be permanently interfered with. Sir Joseph William Bazalgette, C.B., M. Inst. C.E., was consulted on the subject, and he recommended that the sewer at this point and through the remainder of its length should be permanently raised 2 feet; this was eventually agreed upon, and no inconvenience has since been found, but of course the available drainage of the district has been reduced in depth to that extent. From this point the sewer is continued at its original depth along Clark Street and Rosemary Street into Broadmead, about 12 feet deep, and in size 4 feet 6 inches by 4 feet, with a gradient of 1 in 600. Passing under the river Frome it continues along Nelson Street, and formerly discharged into Mylne's Culvert before described and the tidal river, but in consequence of the before-mentioned Mylne's Culvert not being sufficient during floods to carry off the storm waters of the river Frome, the sewers of this district were rendered inoperative, causing the same to be flooded to the level of the Frome; and this sewer has now been connected with the new sewer, constructed nearly parallel with Mylne's Culvert, to be hereafter described in the Avon intercepting sewer district. It was also necessary to convey a small portion of the sewage of this district underneath the Frome branch of the Floating Harbour, which has been done by means of iron pipes discharging into the new Prince Street sewer hereinafter described.

These sewers with a main branch sewer constructed up Ashley Hill, a section of which is given, and some smaller sewers complete the drainage of this district.

The area of this district is about 1288 acres; the length of new sewers is about eight miles, and the cost of sewers about 31,285*l*. The construction of the sewers was commenced about October, 1860, and completed about April, 1866.

The cost of the sewers in this district has been borrowed, as in the former districts, viz., from the Public Works Loan Commissioners, to be repaid in twenty years with interest at 5 per cent.

The rateable value of the district in 1860 was 126,643*l*., and the present value is 197,533*l*.; the highest rate made for drainage purposes was 5*d*. in the pound, and the present rate is 3½*d*. in the pound; the whole of the money borrowed will be paid off in 1880.

6. THE AVON INTERCEPTING SEWER DISTRICT.—This the last

remaining district is bounded on the north by the Floating Harbour, and on the east by the St. Philip's district, and is coloured purple on the plan; it comprises nearly the whole of the old city, which, as before stated, was fairly drained by the late Commissioners, and the existing sewers have been made available by constructing new sewers on either side of the river Avon, so as to connect the whole, and discharge the sewage at present at three points in the river; and eventually the sewage of this district on the north side of the river will be connected with the main outlet sewer on the south side of the river, hereinafter described, by means of iron syphons passing under the river from the north to the south side, and discharged at one point near Clift House.

In considering the drainage for this district it was also necessary to determine the levels for the main outlet sewer with a view, if necessary, of continuing the same to the mouth of the river, a distance of about seven miles; and the portion now constructed is laid at such level as to allow of its being so continued at the same gradient, and to discharge at a level of 3 feet above low-water mark, which will allow of free access to the valves, &c., at the mouth for about three or four hours each tide.

The level of this main outlet sewer being determined, the next point for consideration was the Mylne's Culvert, as to its capacity and level; and with regard to its capacity, it was found that in consequence of the decrease in size from an area of $21\frac{1}{2}$ feet to $9\frac{1}{2}$ feet in the portion passing under the Floating Harbour, the sewer was reduced to the smaller area, and that during heavy storms the waters of the river Frome were forced up the new sewers in the Frome district, thus rendering these sewers for the time inoperative. It was also found that, in order to convey the sewage from the said Mylne's Culvert to the proposed new sewer on the south side of the river Avon, it would require to be lifted by pumping at least 10 feet; under these circumstances, it was eventually determined to construct a new sewer parallel with Mylne's Culvert, but at a higher level, so as to discharge the sewage by gravitation into the new sewer on the south side of the river Avon, and thus relieve Mylne's Culvert of the sewage from the Frome district, and restore the said Mylne's Culvert to the purposes for which it was originally designed.

The principal sewers constructed in this district are the main sewer on the south side of the river Avon, and the Prince Street sewer, constructed to relieve the overcharged Mylne's Culvert, and

running nearly parallel with the same. This latter sewer commences at the Stone Bridge, about 17 feet under the surface, at which point it receives the sewage from the low-level sewer of the Frome district (before mentioned as originally discharging into Mylne's Culvert); the size of this sewer is 5 feet by 4 feet 6 inches, with a gradient of 1 in 890. It then continues underneath the Tontine Warehouses and Clare Street, at a depth of 24 feet, and passes along Marsh Street and Prince Street to the Floating Harbour, under which it passes in two cast-iron pipes, laid side by side, each 3 feet 6 inches in diameter, and similar to the pipes described as laid in Mylne's Culvert. It then continues the same size and gradient to a point in front of the Gaol, and discharges into the tidal river. The principal feature in the construction of this sewer was the laying the double syphon under the Floating Harbour: each pipe was laid in lengths of 9 feet 4 inches and 3 feet 6 inches internal diameter, weighing about two and a half tons, provided with ball and socket joints, turned and bored, also lugs and bolts for bolting the same together; the pipes were continued through the quay walls on either side, and securely built into the walls, having cast-end pieces, the ends nearest the outlet being provided with self-acting tide-valves; the pipes were laid by means of a traveller running on piles, which were driven and the shafts on either side sunk previous to the water in the Harbour being let out; and the time occupied in laying the pipes was only eighteen days; the pipes are laid with a dip of 14 feet in a length of about 80 yards. This sewer with the main branch sewers constructed on the north side of the river Avon, and the old sewers constructed by the late Commissioners for draining the parishes of Redcliff, Temple, and Thomas, and is called the Redcliff Hill sewer, completes the drainage of the district on the north side of the river Avon.

The main sewer on the south side of the river Avon commences at a point opposite Totterdown Lock, above which is situate the outlet for St. Philip's district, and also the outlet for the St. George's district, lying outside the borough of Bristol, but which by arrangement has been allowed to pass through the borough to this point, and the new sewer has been constructed of sufficient size and at such levels as to receive the sewage from these two districts by means of iron syphons to be laid under the river. The St. George's district contributing the sum of 6161*l.* for such use of main sewer, and undertaking to pay *pro rata* for any further

extension of the sewers of the borough, or in case of deodorization a proportionate cost of the same; the size of the sewer at this point being 6 feet in diameter. Passing under Messrs. Hare's premises into the Bath Road at a depth of 34 feet, it continues along in front of Somerset Terrace and Redcliff Crescent to Bedminster Bridge, at which point it will receive the drainage of Redcliff Hill sewer by means of iron pipes to be laid under the river as before described; the sewer then continues along the side of the river, increased in size to 6 feet 6 inches in diameter, at a depth of 30 feet, with an inclination of 1 in 2310 for its whole length; arriving opposite to Mylne's Culvert and Prince Street sewer, it is increased to 7 feet 9 inches in diameter and is at a depth of 46 feet under the surface; it then continues along Coronation Road to the outlet for the Bedminster district, being enlarged to 8 feet 3 inches; it then continues along Coronation Road, passing Mr. Drake's Tan Yard and underneath the fields at the back of Clift House, at a depth of 53 feet, and discharges into the tidal river for the present through the outlet described as the Parsons Street sewer, in the Bedminster district, thus intercepting the whole of the sewage on the south side of the river Avon, and also providing for the conveyance of all the sewage now discharging into the river above Cumberland Basin.

The area of this district is about 518 acres, the length of sewers about $8\frac{1}{2}$ miles; the works were commenced in July, 1871, and completed December, 1874, the cost of the same being 53,419*l*.

The money for the cost of the sewers in this district has been borrowed from the Bank of England for a term of thirty years at $3\frac{1}{2}$ per cent.

The rateable value of the district in 1871 was 132,611*l*., and the present rateable value is 171,688*l*., the highest rate charged for drainage purposes being 6*d*. in the pound, and the present rate is 5*d*. in the pound; the cost of the works in this district is spread over a term of thirty years as before stated.

From the foregoing it will be seen that these drainage works have been designed and constructed for the delivery of the whole of the sewage now discharging into the river above Cumberland Basin at one point, near Clift House, by means of three iron siphons to be laid under the bed of the river from the outlets of the following districts, viz.: First, St. Philip's and St. George's districts; secondly, Redcliff Hill; and thirdly, Mylne's or Prince Street district. The only points of discharge will then be the Clifton

outlet on the north side, and the outlet near Clift House on the south side of the river.

- Having brought the sewage of the borough to these two outlets, the question to be determined is in what manner shall the same be dealt with, and until this point is settled the writer has recommended that all the present five outlets be retained, viz. four on the north side and one on the south side of the river.

It may also be stated that the site of the outlet near Clift House has been inspected and approved of by Mr. Robert Rawlinson, C.B., M. Inst. C.E., and he recommends that 8 acres of land be obtained near this outlet for deodorizing works for the whole of the borough.

The sizes of the several sewers in each district are calculated to carry 5 cubic feet or $31\frac{1}{2}$ gallons per head per diem for a variable population of from 30,000 to 50,000 per square mile, according to the district, and $\frac{1}{4}$ inch of rainfall in twenty-four hours, storm overflows being formed in all cases where possible to provide for any greater rainfall.

The question of ventilation, after many years' consideration and discussion and after the experience of other localities, has been left in the same position as found by the writer, viz., the sewers are without any external openings or means of ventilation, the whole of the street gullies are trapped, and the manholes are all closed down, in which particulars the sewers of Bristol differ from those of nearly all other towns, all external air being excluded. The several districts have for the most part separate outlets into the tidal river, as before described, in all of which districts, with one exception (that of the High Level of Clifton), provision has been made for flushing from the Floating Harbour, or water-courses discharging into the Harbour; but in no case has it been found necessary to have recourse to artificial flushing, there being no deposit in any of the new sewers, nor has it been found necessary to provide other means of ventilation. But in the High Level District of Clifton it was found that during low water, when the outlet was exposed, the draught in these sewers was sufficient to drive the sewer air into some of the houses, and an air-valve was placed at the top of the incline to the outlet which has prevented such draught. The whole of the other sewers being low level sewers, have double tidal valves fixed at their outlets; these valves are self-acting, of cast-iron, and oval or circular in form, they are hung with chains and bedded on india-rubber.

In February, 1871, the writer reported on a proposal for dealing with the sewage of the borough by discharging it only on the ebb of the tide.

The outlets of the present sewers being provided with self-acting valves, which open with the receding tide and close with the rising tide, it was proposed to provide means for preventing the discharge of the sewage during the up-flow of the tide previous to the closing of the valves, by means of penstocks and storage tanks.

In order to ascertain the exact time during which the sewer outlets are closed each tide, an accurate statement was obtained, from Mr. Thomas Gamlin Bunt, Surveyor, of the rise and fall of forty spring and forty neap tides. The 10 feet 2 inch mark on the Cumberland basin tide-gauge corresponding with the level of the invert of sewer on the south side of the river Avon, and the 14 feet 2 inch mark corresponding with the level of the invert of sewer on the north side of the river.

1st. *As to the Discharge on the South Side.*—It was found from Mr. Bunt's statement that the valve of this sewer would be closed for 2 hours 51 minutes during the time the tide would be rising from the 10 feet 2 inch mark to high water, and that it would be closed for 2 hours 26 minutes during the time of falling from high water to the above mark, which together give 5 hours 17 minutes; and in order to prevent the sewage from discharging into the river during the upward flow of the tide, it would be necessary to close the valves before the turn of the tide, that it is calculated would give or require an additional 2 hours 9 minutes, which, added to the above, gives a total of 7 hours 26 minutes as the time for which it would be necessary to provide means for retaining the sewage in tanks.

The above time has been taken during neap-tides, as, from the statement before mentioned, it was found that the outlet would be closed a shorter period during spring-tides than during neap-tides by 1 hour 19 minutes.

2nd. *As to the Discharge on the North Side.*—From the observations before referred to it appears that this outlet would be closed 1 hour 32 minutes during the rising of the tide from the 14 feet 2 inch mark to high water, and 1 hour 25 minutes during its fall from high water to the same mark, which together give 2 hours 57 minutes, to which must be added 3 hours 28 minutes for preventing the discharge of the sewage during the up-flow of the tide,

which makes a total of 6 hours 25 minutes for which to provide means for retaining or storing the sewage.

From the foregoing it will be seen that in order to prevent the discharge of the sewage into the river during the upward flow of the tide, tanks must be constructed to retain the sewage on the south side of the river 2 hours 9 minutes and on the north side 3 hours 28 minutes longer than it is now retained by the present self-acting valves.

The following float experiments made by Mr. Thomas Howard, M. Inst. C.E., Docks Engineer, in December, 1857, and January, 1858, in the river Avon, will show the course of the present discharge of the sewage in the river.

Four experiments were taken on spring-tides.

The float in all the experiments was placed in the river opposite the overfall dam near Cumberland Basin, and nearly opposite the outlet of sewer on the south side of the river.

Floats 1 and 2, which were started on tides of 25 feet and under, were started at 3 hours, and 3 hours and 21 minutes, respectively, after high water, and reached a point outside the mouth of the river before they were met by the flow of the next tide, which carried them back up the river as far as Rownham Ferry.

Floats 3 and 4 were started on tides of about 30 feet in height, being placed in the river 2 hours and 32 minutes, and 3 hours and 9 minutes, respectively, after high water, and were carried down outside of the river Avon, and No. 3 as far down the Severn as a group of cottages near the beach, half a mile below the Portishead Battery Point; the returning tide then brought it back to the starting-point in $4\frac{1}{2}$ hours. No. 4 was carried as far as Portishead Pier with the ebb, and returned on the next tide to Cumberland Basin in $4\frac{1}{2}$ hours.

The result of these experiments shows that all sewage discharged at 2 hours 26 minutes after high water (the time at which the sewers will commence discharging) will pass entirely out of the river Avon, as in case of spring-tides as far down Channel as Portishead Battery Point, but it is also evident that the returning tide will bring back any floating substance; though in all probability the sewage (if it returned at all) would be in such a diluted form as not to be in any way offensive.

Three experiments were taken on neap-tides.

Experiments Nos. 1 and 2 were made on tides of an average

height of 22 feet 6 inches, but a considerable difference is observed in the time after high water at which the float was put into the river.

In the latter, 2 hours 2 minutes had elapsed, and the float reached the mouth of the river before meeting with the turn of the tide, which carried it back to a point near the old Engine house (now removed).

In No. 1 the float was not started until 4 hours 3 minutes after high water, or double the time of the previous experiment, and it only arrived off the Shirehampton Brick Yards before it returned.

Float No. 3 was started on the lowest tide experimented on, the height at Cumberland Basin being only 18 feet 8 inches, and it was started nearly 3 hours after high water; it reached a short distance below the Powder house in $3\frac{1}{2}$ hours, when the flood-tides came on and carried it back as far as the Engine house before named.

From these experiments it will be seen that during spring-tides, the sewage would be carried down the Bristol Channel nearly as far as Portishead, and would return in such a diluted form as not to be in any way offensive, but that during neap-tides, or all tides below 22 feet in height, no portion of the sewage would pass out of the river, but would flow backwards and forwards with each tide until the return of the spring-tides, when it would be carried out into the Bristol Channel as before stated, and on referring to the tide tables it will be found that about 226 of these low tides occur each year.

Under these circumstances it has been determined not to incur any further cost in the matter at present.

In November, 1873, the writer reported as to the practicability of uniting the two outlets by bringing the sewage of the north side to the site near Clift House, this site having been approved of by Mr. Rawlinson (as before stated) as in all respects suitable for dealing with the sewage in any manner that may be determined on, and it was proposed to accomplish this in one of two ways, viz.

1st. By carrying the sewage across the river by means of iron syphons at or near its present outlet, and then by sewers to be constructed along the south side of the river to Clift House.

2nd. By means of iron syphons carried under the river, at or near the new entrance lock gates at Cumberland Basin, at which point the sewage of the Clifton low level district and the portion of the Frome district could be intercepted and conveyed to the south

side, leaving only the Clifton high level sewage to be dealt with ; and as the level of this district is so much above that of the low level district, advantage could be taken of the length of sewer now conveying the low level sewage to the high level outlet ; by using this length of sewer as a syphon, and forcing the sewage from the high level district against the gradient of the sewer to the same point near the new lock gates to Cumberland Basin, now proposed for the conveyance of the sewage of the low level district by means of iron syphons across the river to the south side, to be continued thence by double or single culvert, as may be hereafter determined, to the proposed outlet near Clift House ; and the only objection to the same is the use of the present sewer with the gradient the reverse way to the flow of the sewage, but this objection could be met by providing means for periodically flushing this length of sewer ; at the same time it will be a question to be hereafter determined if it will not be better to adopt the first-named plan : the whole sewage of the borough would then be brought to the one site near Clift House, and could be dealt with in any manner that may be hereafter decided upon.

In conclusion, it will be seen that at present no determination has been arrived at with regard to the ultimate disposal of the sewage of the borough, which is still discharged into the tidal river at the five separate outlets. The total cost of the drainage works to the present time, less 6161*l.* paid by the St. George's district, has been 163,071*l.*, which, taking the estimated population of the borough at 202,950, will give as the cost per head 16*s.* 0*½d.* This amount has been raised by rates in each separate district, varying from 1*s.* 6*d.* to 2*d.* in the pound. The whole cost in the two first-named districts having been repaid, the special rate has ceased ; in the next two districts it will expire in 1878 ; in the fifth district in 1880 ; and in the last district, the amount borrowed having been spread over thirty years instead of twenty years as in the other districts, the repayment will extend to the year 1901.

The average death-rate before the construction of the foregoing works was 28.0 per 1000, and for the year ending January, 1877, it was 22.7.

APPENDIX A.

No.	Name of District.	Area.	Length of Sewer.	Cost of Work.	Time of Commencing and Completing Work.	
				£	s.	d.
1	Clifton high level ..	1041 acres.	11 miles.	34,014	June, 1855	July, 1857
2	Bedminster ..	876 "	5½ "	11,424	October, 1855	July, 1858
3	Clifton low level ..	279 "	8 "	13,969	June, 1858	July, 1859
4	St. Philip's ..	685 "	7 "	25,121	August, 1858	November, 1861
5	Frome intercepting ..	1288 "	8 "	31,285	October, 1860	April, 1866
6	Avon intercepting ..	327 "	8½ "	53,419	July, 1871	December, 1874
	(water) 191 "					
	Total ..	4687 acres.	43 miles.	169,232		

For the first five Districts the money has been borrowed from the Public Works Loan Commissioners at 5 per cent., to be repaid in twenty years; and for the sixth District, from the Bank of England at 3½ per cent., to be repaid in thirty years.

AMOUNT OF RATES COLLECTED IN EACH DISTRICT.—B.

No.	Name of District.	Rateable Value at commencement.	Present Rateable Value.	Amount of Rate in the Pound each Year.																					
				1855	1856	1857	1858	1859	1860	1861	1862	1863	1864	1865	1866	1867	1868	1869	1870	1871	1872	1873	1874	1875	1876
		\pounds	\pounds																						
1	Clifton high level	75,200	149,178	9	8	1	1	10	9	9	8	8	8	8	5	5	5	4	4½	4	4	2	paid off		
2	Bedminster ..	20,767	39,736	1	1	1	1	1	1	1	1	1	1	1	1	1	1	8	7	7	6	5	5	do.	
3	Clifton low level	50,315	72,970	1	1	10	9	9	6	6	6	6	6	6	5	5	4	4	4	4½	4	3½	3	3	
4	St. Philip's ..	67,151	127,277	1	1	1	1	9	9	8	8	7	7	7	5	5	4	4	4	4	4	3	3	3	
5	Frome intercepting	126,643	197,593																						
6	Avon intercepting	132,611	171,688																						

DISCUSSION.

Mr. PARRY (Reading): I should like to ask, Have you felt no injurious effects at all from not ventilating the sewers here?

The PRESIDENT: None whatever.

Mr. PARRY: And if you had the drains to lay out now, you would lay them without ventilation?

The PRESIDENT: Yes, I should.

Mr. ELLICE-CLARK (Hove): I must say, I am exceedingly surprised to hear Mr. Ashmead say that the sewers of Bristol are unventilated; and I am still further surprised to hear that if he had to lay them out again he would lay them out upon the same principle, or non-ventilation. I should like to have heard from him whether the majority of the sewers are brick sewers or pipe sewers? whether the majority of the sewers—and the main sewers—have a constant flow? whether any experiments have been made with regard to the velocity of the sewer air? whether there have been qualitative and quantitative analyses made at different times of the year? whether the temperature has been registered in the sewers? also, what the condition of the sewers has been for workmen to enter after they have been closed for a long period? also, whether the houses of the town are connected directly with the sewers and trapped? whether the water-closets connected with the majority of the houses are inside or outside? and whether the authorities are perfectly certain by actual inspection that all the down spouts are effectually trapped? and the same with regard to the gullies and openings to the inlets of the sewers? Because it does appear to me strange that, after the analyses we have seen and the experience we have had of sewers in a large number of towns, and the tabulated statements given to us showing that sewer air and sewer gases generated in sewers unventilated have been productive of a large amount of injury to the health of the people—we should have unventilated sewers advocated in the case now before us, in a large city. I have taken, myself, considerable trouble with regard to sewers and sewer ventilation, but on a much smaller scale than the sewer ventilation—or rather “non-ventilation,” of Bristol; and I have found that the condition of pipe sewers with intermittent flow without ventilation has been very

bad indeed; and the inhabitants along the route of the sewer have complained very loudly of the sewer gas in their houses, more especially over sewers of a steep gradient. If you refer to our Proceedings, you will see there a tabulated statement of the different experiments and the analyses made of sewer air; and it is the first time I have heard—I was going to say for some years—but it is the first time that I have heard at all, that sewers ought not to be ventilated. I shall be very glad to have from Mr. Ashmead information as to some of the particulars I have asked him, because I think, unless there are some really authoritative details and particulars as to these various matters, it is impossible to say whether the sewers are ventilated or not. In some towns we know they do not trap the house connections and do not trap the down spouts, and the gullies being improperly trapped also, the sewers are really ventilated in that way, though they are not ventilated in the centre of the streets. I am just now constructing new sewers in a portion of Brighton, and so far from not having ventilators, we are placing them about every 200 feet, and I am following so far as I can the Leeds plan. Wherever I can get the gully away from the house, and there is a chance of the sewer air being disseminated, I untrap that gully. My short experience goes to prove that if you could possibly have sewers open I would have them open; and that the more openings you can get in sewers in towns the less probability there is of the sewer gas arising, and of being, as I believe medical men have always taught us, a very injurious element in the healthy condition of all towns.

Mr. R. VAWSER (Warrington): I should like to hear what is the effect of a constant flow of sewage through these syphons, with a dip of, in one case, I see, 7 feet and another 10 feet. Some particulars of the effect of sewage flowing for long periods through syphons would be interesting. With respect to the non-ventilation of sewers upon which Mr. Clark has questioned you, I presume from your paper that all the houses are disconnected from the drains—effectually disconnected, as I understood it; and that whatever sewage vapour and gases there may be escaping from the sewers, they cannot possibly by any means escape into the houses: that the drains in the sewer in the summer for instance are effectually disconnected, and also from the water-closets. I must confess I am an advocate for free ventilation; and unless you can show that by some means or other the gases are prevented from entering into the houses there is doubtless some ventilation. We

know that gases are formed in the sewers, and that they will get out if there is any connection at all with the houses. If there is simply a water-closet connected with the drain, and this separated from the house simply by a water-trap, the probability is that the sewers are ventilated into the houses. There is the same thing probably with the cellar drain—simply a drain communicating directly into the sewer without any intermediate trap, except an ordinary 2-inch water-trap. In Warrington we always compel all new houses to be built entirely disconnected from the sewer, and I conceive from your explanations that that has been adopted here: and more than this, that the same rules have been applied to all the old houses. At any rate, we shall be glad to know if that is so. Then as to the tide flaps; as my town happens to be upon a tidal river, anything connected with tide flaps will be interesting to me, because I could never get a tide flap that would really keep the water out. I shall be glad to know if the arrangement you have from tidal flaps suspended by chains on beds of india-rubber is found to be effectual in keeping out the tide. I have sometimes found that corks, pieces of wood, and chips, get in and impair the efficiency of the flap after the tide, and it finds its way into the cellar. Then there is another thing. In describing the flow of your water and the sizes and the designs of your main sewers, you mentioned certain statistics, and you stated that the sizes of the several sewers in the districts are calculated to carry 5 cubic feet, or $31\frac{1}{2}$ gallons per head per diem for a variable population of from 30,000 to 50,000 per square mile—and “ $\frac{1}{4}$ -inch of rainfall in 24 hours.” I suppose there is abundant opportunity for overflow for storm water? In my town (Warrington) last Sunday we had $2\frac{3}{4}$ inches of rain in one day, and I am afraid that any sewers that were designed for so small a quantity of rainfall as that you mention would have a tendency to come to grief under that state of circumstances. As to the cost and carrying out of the various works, does the cost you have mentioned include the cost of the branch drains and sewers—the sewers of ordinary private streets; or is it for the main drainage works only? I fancy you seem to have the same system in force here as we have of draining by districts, and charging separately to the districts. In my own case we do not charge the owners of private streets for the sewers for the drainage at all, but the whole of it is levied on the rates. I shall be glad to know if that is the custom here in Bristol. I am exceedingly pleased with the interesting paper you have read to us,

and I shall be glad to digest it at leisure ; and I trust it will not be long before we shall have copies placed in our hands.

A MEMBER : Can you explain how you effectually separate your sewers from the houses ?

Mr. VAWSER : The ordinary gully is constructed on the outside of the house. There is a water trap between the drain and the yard, and the pipe from the house is some inches from it : then, if there is an escape of gas from the trap, as there would be in process of time, it escapes into the yard.

What about the water-closets ?

Mr. VAWSER : Well, at present our water-closet pipes are connected with the sewer ; but we have some new regulations just coming into force that will avoid that.

Mr. HARPUR (Merthyr Tydvil) : As one of the members of the Association, I feel much indebted to you, sir, for the excellent paper you have read, and the very interesting remarks you have made. A good deal of the discussion seems to me to turn upon the question of ventilation. Now the " ventilation " of sewers is comparatively a new question. You commenced your sewerage works, I perceive, under the old Board of Health, previous to the establishment of the Local Government Board. Mr. Austin, whom you refer to, was an officer under the General Board of Health, under the old Act of 1848. Under that Act many sewers of towns were laid down, and no idea of ventilating them was propagated whatever. For many years the idea of ventilating the sewers was in abeyance ; but my own opinion at the present time is, that if you are laying out the sewerage of Bristol or any other large town, the most effectual way of ventilating the sewers, and the most effectual way of relieving the whole place of any deleterious effects arising from sewer gas, would be to make all your street gullies open gullies, and not trapped ones. If you make them all open and untrapped, the drains would keep free, and from the gas, if any arising, no nuisance will be felt. Mr. Ellice-Clark has said that if he can get the gully a sufficient distance from the dwelling he leaves it untrapped. I question whether that would not be only a partial remedy, and attended with disadvantages. If you can get the whole untrapped it is better, as they would act as ventilators ; and the most effectual and the best ventilators that can be devised in connection with the sewer system, in my opinion, is to leave all the street gullies untrapped and let them act as ventilators. The gas would be so diluted then that little or no evil would be felt in any case. I have

been exceedingly pleased with the practical paper read by the President. It must have been a considerable burthen for Bristol to pay off the whole of this debt in twenty years, after borrowing the money at 5 per cent. interest. In my own case, at Merthyr Tydvil, we have laid out in sewage works and sewers something like 180,000*l.*, and we now owe 180,000*l.* for different works of one kind and another. I have just proposed to the Board there to bring the whole of the loan debts into one sum, and endeavour to get the authority of the Local Government Board to amalgamate the whole, and thus start afresh, and spread the payment over some fifty years. And I have reported to my Board that if they only adopt that principle, and carry it out by arranging with the present lenders, and paying them the value of their loans and a premium for giving up these loans, and start afresh, they would give their town 9500*l.* a-year in interest and principal. It will indeed prove a very great boon to the place. I am convinced that moneys ought not to be borrowed and spent upon works of this kind, to be paid off in so limited a period as twenty years, at 5 per cent. It is a heavy burthen upon the people. Fifty years, I think, should be the shortest period, and the interest ought not to exceed $3\frac{1}{2}$ or 4 per cent. The difference in the annual payment upon a large sum at $3\frac{1}{2}$ per cent. for fifty years and at 5 per cent. for twenty years would be very large indeed.

Mr. D. J. HUMPHRIS (Cheltenham): Mr. Ashmead's paper has been so full in itself that it leaves little to be said; while the questions of Mr. Ellice Clark will no doubt elicit a good deal of valuable information. With reference to the suggestion that the whole of the gullies should be untrapped, I have no doubt it would be a considerable benefit that the air should be diffused in the manner indicated throughout the town so generally; but one evil to guard against is the great accumulation of road dirt which the trap would prevent, in addition to preventing smells. But that is a difficulty that could be met with in another way. One is certainly surprised to hear the statement, that without any ventilation of the sewers, the state of things in Bristol is so satisfactory. I have, myself, always been desirous that ventilation should be carried out efficiently and well, and I cannot help thinking that it is the right principle. The sewers appear to have been laid out upon very excellent gradients, and there is no amount of deposit to any great extent, which is extremely favourable. The paper itself is a very valuable one, and I take the opportunity of thanking

Mr. Ashmead for it, and the useful and practical remarks he made in his statement previously.

Mr. HARPUR (Merthyr): I see no difficulty in dealing with the soil, dirt, and *débris*, and so forth, and at the same time leaving the gullies open.

Mr. C. JONES: The question is really one of so much importance that I am sure our friend Mr. Ashmead, in answering the questions, will clear away some of the doubts that exist in our minds with respect to the non-ventilation of the Bristol sewers. We had heard, previously, that it was an unventilated town, and if we had heard that there was a large amount of fever—while the principle might have been a success—I should still have certainly been inclined to have put the two things together—the non-ventilation and the fever. But it is an extraordinary thing that a large town like this should have such sewers unventilated—hermetically sealed—and yet the health of the town be such as it is. That there should be no evil or difficulty arising from it certainly staggers me, and creates a doubt as to whether Mr. Clark is not right when he tells us that, probably, nine out of ten of the rain-water pipes are ventilating shafts. If so, that would, of course, explain the difficulty, and we get over it directly. Another difficulty also arises in the mind, where the gas is to go out, because the pressure seems to me to be enormous. I cannot imagine but that there would be some damage arising somewhere. If it is a fact that there is no possible ventilation in these sewers, it is a most extraordinary thing, to which, indeed, there is no parallel in England. I myself find continually grumbling when some man-hole comes near somebody's door, and it would be one of the greatest sources of satisfaction to me in my life if I could say, "Well, now, gentlemen, I propose to stop them all up." But I am afraid upon the spur of the moment there would be a "blow-up" at the Board, if not in the sewers. As to keeping the gas out of the house, I do not think there is much difficulty about that. Just now I am carrying out some private work, and adopting a plan which I saw in a report of Dr. Buchanan's at Croydon, and an admirable thing it appears to be. He has his syphon between the main sewer and the house—near the house, probably within a few feet of it; and he then carries up between his syphon and the house a ventilating pipe—between the syphon and the house—untrapped, and coming up into the path with a little grating over it, and a few holes in it. The pipe is then con-

nected with the soil pipe and the house ; then, of course, there is a ventilating shaft, equal to the diameter of the soil pipe, carried up, instead of a little trumpery inch or inch and half pipe ; the shaft is carried up the same size as the soil pipe above the top of the house. The sewer gas is thus virtually shut off from the house. A current of air is continually drawn up a long pipe, so that although it is open to the house drain, there is no inconvenience whatever attached to it, and it seems to me the most convenient and perfect mode I have yet met with. The pipe attached between the syphon and the house seems to me to be an admirable mode of dealing with the difficulty, so far as the soil pipe connected with the house is concerned. The ventilating shaft is carried up two or three feet above the house. If we can keep the soil pipe clean, and a current of air passing through it, the sewer gas may pass into the street, and I don't think that any disease or accident can arise from it ; have plenty of man-holes and no charcoal. With regard to the latter, it is strange how we alter our views. Only ten years ago, Mr. Rawlinson would not have passed a plan without a "charcoal basket," and every other commissioner would have acted in the same way, and would have thought anyone mad to submit a plan without a charcoal basket. They would have said, "You must have charcoal baskets, we cannot pass the plans without ;" but now they would not think of passing them with charcoal baskets. And so these changes are continually passing over our vision. In some cases, of course, charcoal baskets may be beneficial. One day I found that a man had had a charcoal basket taken out and put in again, and I found that he had done it most effectually. He had taken it out, crammed it as full as he could cram it, so that not the slightest breath of air could come through it. This went to prove that the charcoal is absolutely useless except as a dam, or, in other words, to carry out the principle of Mr. Ashmead's sewers—if he had to "ventilate" them with charcoal baskets, he would cram them as close as possible, so that there could be no ventilation at all. I am much obliged to him for his paper, which has carried us, as it were, all over Bristol, and which has given us a review of the growth of this great place in the able hands of our President.

A MEMBER: Have you extensively used these traps for the main drains without finding any inconvenience from them with the syphon ?

Mr. C. JONES: Oh, yes.

Mr. HUMPHRIS: I know they are in use, but I have a dislike to them; but I take care the ventilation is good with the ordinary traps, and with a continuous flow of water in the drains there is not any risk of accumulations.

Mr. JONES: In the last work of the kind I did, I had syphon traps to every connection we made; in all cases it prevented the entrance of sewer gas; the syphon trap was put between the sewer and the house.

Mr. LOBLEY: I have used these traps frequently, and I have always recommended that plan. The other day I alluded to it in the Home Counties Committee, but it did not seem to find favour there, and I should therefore like to hear what the opinion of the meeting is upon the subject. They thought the syphons were liable to be stopped up and give trouble, but I never had a single case of a syphon being stopped up. I should like to know whether Mr. Jones has.

Mr. JONES: No.

Mr. LOBLEY: That was what was suggested at the Ipswich meeting, that these syphons would get stopped up.

Mr. JONES: I have many hundreds in use, but I never had any stopped up.

Mr. LOBLEY: The general way is to carry from the soil pipe up to the roof a small pipe, which of course ventilates the sewer, because there is no syphon between the soil pipe and the sewer; but it seems to me that the pipe as a rule is too small, that it should be carried up full size, and that a syphon should be used as described.

Mr. NEWMAN (Ryde): I have used syphons but recently in connection with the system recommended by Dr. Buchanan in the report at Croydon. And I join Mr. Jones in praising it as the most perfect system of house connection I have seen. I quite agree that the soil pipe should be continued the full size until it is two or three feet above the roof. There is one thing I should like to ask our President—a question upon which I think Mr. Clark did not touch—that is, the size of the smallest sewer?

Mr. CLARK: In Ramsgate I put down nearly 2000 drains, all having syphon traps, between four and five years ago, and I do not know of a single instance of one having been stopped up. Then the house connection of Brighton—600 houses forming part of my district—the whole of them have syphons, and I have never heard of their having been stopped up.

Mr. LOBLEY : You did not support my views at Ipswich ?

Mr. CLARK : They have no sewers at Ipswich, so I do not think they have water-closets.

Mr. PARRY (Reading) : I believe in it so much that one of the first things I did at Reading was to apply it to my own house.

Mr. VALLE (Stow-on-the-Wold) : I am firmly of opinion, on the contrary, that the time will come when we shall have to do away with the ventilation of sewers. Why not ? It must eventually have a tendency to contaminate the air which we breathe. In our sanitary progress it should be our principal study to keep all sewer gas entirely under subjection. I am very pleased therefore to hear Mr. Ashmead informing the Association that he is enabled to drain a great city like this without having to ventilate the sewers into the public streets. Because if, for instance, I or any gentleman present were going over one of the opening gratings of ventilated sewers, what might be the result ? They must naturally swallow some of the poisonous stuff ascending from the sewers. I hope, if the Secretary and President will give me time to-morrow to say a few words upon the subject, to be able to show that it is quite unnecessary to ventilate sewers to such an extent as is carried out now in towns generally. I believe the time will come when we must bring all this sewer gas down and condense it, and keep it entirely out of the air, whether the sewers are discharged by tidal rivers or by other means inland. Why I assert this is, that we have now got some towns drained in this way, and it acts remarkably well, as instanced in the present case. I have got the house where I reside drained in the same way : there is no ventilation at all. It can be done away with ; it is not necessary. I have it in operation in the house I live in ; and in connection with the sewers there is no regular trap—no patent trap ; it is not trapped at all in the way we generally understand “trapping ;” and I may therefore say, so far as my personal opinion goes, we are advancing upon this point.

Mr. PARKER (Bridgwater) : The question of the ventilation of sewers is one which I thought had been quite sufficiently “ventilated ;” and I must express my surprise—I will say my sorrow—at hearing an engineer of the eminence of Mr. Ashmead recommend the non-ventilation of sewers. I thought amongst practical engineers the question had been settled years ago. In Bridgwater we have expended a large sum in putting in ventilators. It is quite true that a great deal of prejudice exists, but I had con-

vincing proof the other day that it is only prejudice. In one case where two open ventilators had been much complained of, I got the foreman to cut off one of the ventilators completely, without letting the people who complained know anything about it. The result was that the very persons who had complained before about this particular ventilator continued their complaints. In reply to questions they said, "No; the ventilator is a positive nuisance; it is not a bit better since the men repaired it." Whereas it had been entirely cut off. There was another similar case; so that I had two distinct cases showing how prejudice operated upon this question. It is indeed only prejudice, and nothing else. I had entertained the hope that we had come to recommend unanimously full, free, and open ventilation. I do not know whether you are not going to have a gas explosion or something like it in Bristol if the sewer gas has been sealed up all these years in the city. The question is, Is it there still? I very much doubt it myself.

Mr. MASTERS (architect, Bristol): I differ from my friend Mr. Ashmead in the matter of sewer gas. In my own house I have a very capital trap, a nine-inch one, with some special arrangement for ventilation, which I can turn off or on, as I like. And although my closet is situated out of doors, and gets a current of air constantly through it, still now and then I find a peculiar bubbling noise going on there. I get a quantity of air passing, and the closet is very disagreeable for a time. There is another thing, though a little perhaps outside my calling, for I confine myself more particularly to the inside of the house; but, during the remarks of a gentleman here, relative to leaving all the sewer gratings open, it struck me that the plan might act very well in a level country, but here we have to deal with gradients, some of them 200 or 300 feet above the others; and if all our sewer gullies and gratings were open, the air would certainly pass into the lower ones and carry the sewer gas up to the higher ones, so that the higher parts of the city (which I am satisfied have more sewer gas than the lower parts) would be inundated with bad air by the sewer gas being driven by the fresh air passing in below and out above. We should have fresh air, perhaps, but the question is, whether we should not have the sewer gas carried in a cumulative form to the upper districts of the city. In reference to that part of the paper in which the use of wooden blocks is spoken of for the streets, I think I have suggested it before, but in the American

streets I understand that before they lay the blocks and before they do anything with them, they are all thoroughly dried, so as to drive out all the moisture. They are then put into some composition of tar, or something of that kind, before being put together. I thank Mr. Ashmead for his reference to the little book which I have published on the subject of sewer gas and house drainage, and I shall be glad to hang a diagram up in the room here, and, if acceptable, show the mode suggested for keeping the sewer gas out of a house.

Mr. LOBLEY: With regard to the drains confined to the upper part of the town, I may say that in my town we have 350 feet difference in level, but the gas from the lower sewers is effectually prevented from going to the upper levels by air valves.

Mr. LEMON: I think we may congratulate you in the presence of Mr. Vallé, of Stow-on-the-Wold, on being still found alive and well. I cannot, however, go with you in the matter of non-ventilation, though I am willing to admit that Bristol is exceptional in many respects, and what you do here perhaps could not be done in many other towns. The gradients are steep, and there is an immense difference of level; and your sewers have a good supply of water, and therefore sewer gases do not generate perhaps to the same extent that they do in other sewers. That may account for the absence of ill effects of non-ventilation in your case. You tell us that there is a rush of air in the outlet at certain periods. Would that tend to show that the sewers want the admission of fresh air? I find when I make openings in sewers they not only act as outlets, but inlets in certain circumstances; therefore the air in the sewers here is largely diluted. My friend Mr. Vallé says he is going to try to do what others have been trying to do for many years, but which is an utterly impossible thing, viz. to bottle up a stink. A stink is a very unruly animal—he will have free play—and the very best thing you can do is to let him have free play; he will get out of the first hole that is made for him if you only make it; and that, I think, gets rid of the objection of the upper part of the town getting the whole of it. As regards trapping the gullies, when I was at Leeds the committee asked me what I should do as to the ventilation of sewers. I said I should put openings in the streets. They said, "Why, you will have all the stinks in your streets!" Yes; but that is better than having them in the houses. They untrapped all their gullies and trapped all their houses; and that is a good thing. The gullies are not effective as ventilators when you want them during heavy

rains, because the outlet pipe from the gully is partly filled in heavy storms. And for ventilation you should provide artificial means by openings in the streets. And if you get a smell you would do well to take the advice Mr. Rawlinson once gave to a deputation who waited upon him and said, "Our ventilators are a nuisance—they smell." "The best thing," he said, "for you to do, if you have two ventilators that smell, is to put another ventilator in between those two." I believe the cause of your having smells from ventilators is that you have not enough of them. What local boards in many cases do is this: They send out circulars and find that large towns are ventilated—that the majority of them are ventilated. They are a little nervous over the matter. They are advised to put in a couple of hundred or a dozen ventilators, as the case may be; but they say, "We don't do that; we will put in a quarter of the number." And what is the result? They put in this utterly insufficient number, and if there is a nuisance arising from the smell of these few they don't put in any more; whereas if they had taken the advice given them by their own officer, and put in the whole number, the objection as to the escape of sewer gas would never have arisen. It arises entirely, in my opinion, from a want of sufficient ventilators. I was rather surprised to find that the Bristol Local Authority had borrowed money for twenty years at 5 per cent. Of course that was done in the old days of the Local Board of Health. And while upon this subject, I will say that the Local Government Board are taking what I consider a false step in the matter, and they will retard sanitary works in a great measure; that is to say, they have decided now to lend money fifty years at a low rate of interest for sanitary works and waterworks, and they will not lend money for other purposes. There are street improvements and other large sanitary undertakings. I notice in reading the paper since I have been in Bristol, that the Sanitary Authority here are going to borrow 194,000*l.*, and are obliged to pay for it 4½ per cent. I say they ought not to pay anything of the kind. They ought to receive encouragement from the Public Loan Commissioners, and should have the money from them at 3½ per cent. As regards the rainfall alluded to—a question in which I have had some experience—I find that Mr. Ashmead has adopted the same principle as in London, where they make provision in the metropolitan main drainage for ¼ inch of rainfall. Mr. Vawser, of Warrington, just now said that in one day they had had there 2½ inches of rain. Well, no one would

think of providing for $2\frac{3}{4}$ inches of rain; you would get enormous sewers. The only means of providing for that is by storm overflows. The late Mr. Simpson was an advocate for providing sewers for a heavy rainfall in London; but large diagrams were got out showing the absurdity of such a proposition, and it was eventually decided to take the ordinary rainfall, which is a quarter of an inch, and provide for any excess by storm overflows. And I think that that is the proper course in all large towns where you are carrying on drainage works.

Mr. ASHMEAD: As regards the ventilation of the main sewer, I think the question has been answered by the gentlemen who have advocated the disconnecting the houses from the main sewers. If you do that, what do you ventilate the main sewers for? If you cut off all connection you cannot possibly get gases into your houses. Therefore, unless you want to be continually getting into the main sewers for sundry purposes, you do not want to ventilate them. We say we do not open our sewers to examine them, or do anything with them. We do not want to go into them, and don't want to ventilate them; we don't know, in fact, that the gas is there at all. In the first place, the sewers, I may reply, are all made of brick; we have no main sewers of pipes, excepting a few short lengths. We never flush them; we never have had occasion to spend a penny for water for flushing purposes in any shape or form; the flow of water is always sufficient. I may say here that we have in Bristol a good supply of water from the Water Company; we have always found that sufficient for every purpose; the flow is constant and the supply constant. With reference to the velocity of the sewer air, we have never ascertained it, because we have never troubled about it, or any other analysis relative to it; we have made no experiments whatever. Some two or three years ago a question cropped up, and I was requested to make some experiments and ascertain what could be done; but really there was nothing to do, and nothing was done, in the matter. As to the question whether after the sewers have been closed the workmen can enter, we have never found any difficulty, if the workmen have to enter, which is very seldom. In some of the old sewers in the old parts of the city we have had gas, but in none of the new sewers, and all we have to do then is to open two of the manholes instead of one, the one ventilates the other, and the men can go in immediately. The water-spouts in no case enter the sewers directly, and consequently they are always trapped, that is to say,

they are discharged immediately into the cisterns as a rule. The water-closets are generally outside the houses in the inferior houses, but in the better class of houses we have one closet inside and one outside. The whole of the gullies are trapped, and there is no opening of any description from the sewers that I am aware of. Of course, Mr. Clark, in advocating open sewers, knows that if entirely open they are not sewers. (Mr. CLARK : I said if practical.) They would, in fact, be open ditches, nothing more or less. The great object of sewers is to confine the sewage within a certain area, and not to allow it to be open to everything. Mr. Vawser has asked about Mylne's Culvert—its construction and size. That culvert was constructed seventy or eighty years ago by Mr. Mylne, but the syphon part (the pipes beneath the Floating Harbour) is only 3 feet 6 inches in diameter, whereas the sewer on the other side is 5 feet in diameter. Consequently, there is a great contraction at that point. In the new sewer in Prince Street I have put in a double line of pipes, so as to maintain the area, and I cannot understand why Mr. Mylne in his sewer should have only put in one pipe. I cannot say that all the houses are disconnected, but in every case we insist upon the water-closets, and the privies in private houses, and all the drains, being properly trapped; and of late years we have in many instances had a syphon trap put in between the main sewer and the house, and ventilating pipes from the house carried, but we have not insisted upon this. It has been done at the expense of the builders, and at the suggestion of the architects or owners, without our interference. Our tide-valves are perfectly tight. I don't know that there is anything to complain of about them at all. We never have any trouble with them, and never examine them, except in one case in St. Philip's, where, from some chemical action, the chains were eaten through so deeply that the valves dropped down. We renewed the chains, of course, and it was all right. The india-rubber is let into a groove; it is about half an inch square; the valve shuts upon it, and it is perfectly tight. With regard to the quarter of an inch rainfall, Mr. Lemon has answered that, and I need not say anything more about it. Mr. Vawser mentioned about the cost of the sewers being paid for in districts. As I stated, the whole borough has been laid out in districts, but that does not include private streets. In all private streets we require the owners to make sewers at their own cost, we simply finding the outlet. With regard to the charcoal baskets, there is no doubt that what Mr. Jones has stated is a fact;

... if you have the charcoal used as he
I think my plan of non-
There is no
some of the open
my
the rush of air at low
one instance only,
the sewage is
the mouth is
but I constructed an
Mr. Lobley has
and that is some

THE WATER-BEARING STRATA OF THE CITY OF BRISTOL.

By W. WALTER STODDART, F.G.S., F.C.S.,

CITY AND COUNTY ANALYST, BRISTOL.

PERHAPS the water-bearing strata of the city of Bristol and its immediate environs are more varied than those of any other city in the United Kingdom. The well-known complicated and long list of geological formations on which it is built must render the question of water supply a very difficult one. Some of the strata are of flinty hardness and perfectly impermeable, while others are soft and shaly, and consequently very pervious. The geological character of any locality will often determine the probable purity or impurity of a well, and our city is pre-eminently an example of this. In Clifton and Kingsdown we have thick and impervious beds dipping to the N.E. at an angle of 30° to 70° . In the parish of St. Paul we have horizontal beds of porous triassic sands. In St. Philip's we have alluvial beds of peat and gravel; while in the outlying districts of Stapleton and Fishponds thick layers of pennant rock so broken up by innumerable fissures that every well is full of surface water.

Bristol, from the rapid dip of its fundamental strata from an altitude of 300 feet above to 20 feet below the mean sea level, at an angle of 30 to 50 degrees, may be considered unusually well situated for drainage purposes, yet this very character is the worst possible one for the purity of our well water. No well, especially those in the low-lying parts of the city, is free from liability to sewage contamination from the great hydraulic and lateral pressure.

The water-bearing strata may be divided into four kinds:

1. Where the beds dip greatly, and are quite impervious to the passage of water except through their joints and divisions.
2. Where the beds dip greatly, but are fissured in all directions.
3. Where the beds are horizontal and impervious.
4. Where the beds are horizontal and pervious.

As an example of the first condition we may instance the silicious beds of the millstone grit that form the northern boundary from Brandon Hill to Cotham. The water flows *between* the strata, bringing with it comparatively unchanged all that the water has dissolved from the surface of the ground. On the west side of Brandon Hill are two copious springs, only separated from each other by a few feet of millstone grit. Each of them is abundantly supplied by water from Clifton and Durdham Downs, and may at any time be influenced by the extension of buildings and any other sources of contamination that impinge on the strike of the beds between which the water flows. A notable instance of this came under my notice a short time since at the base of Kingsdown, which is placed at the summit of a millstone grit hill. At King Square was a well that had supplied a good potable water for many years, the chemical character of which gave, on an analysis made twenty years ago :

Free ammonia	0·03 parts per million.
Albumenoid ammonia	0·04 " "
Chlorine	0·02 grains per gallon.
Nitrates	none " "
Total solids	27·41 " "

Four years since suspicion was raised from a peculiar taste, and another analysis was made. The result was :

Free ammonia	1·25 parts per million.
Albumenoid ammonia	0·39 " "
Chlorine	3·13 grains per gallon.
Nitrates	6·0 " "
Total solids	102·4 " "

On examining the direction of the dip of the beds in the usual way they were traced to three houses in Kingsdown Parade, at an altitude of 250 feet, when on inquiry abundant evidence was found of the cause of contamination.

In former years, when the priory of St. James was in existence, the monks had a well in their kitchen garden supplied from the same hill. So good was this water, that the city authorities formed a conduit for the supply of the citizens. Now, the very water which this conduit supplies is undoubtedly so impregnated with sewage that it cannot be swallowed without risk. In cases like these no effective and perfect destruction of organic matter by filtration through a porous clay can take place. The same thing occurs with our limestone range of rock. When their surface was

covered with green fields the water supply was good, but when it was built over and streets were formed the water became naturally polluted with the ordinary effects of overcrowding.

The water supply of Stapleton and Fishponds is a good example of our second division. As a rule, every well is connected with each other, except where a fault occasions a mechanical obstruction. So full is the pennant grit on which this locality is situated, and which is a member of the coal-measures, that the water both of the wells and empty coal-pits is identically the same, and was proved at a recent trial to be very impure, from the large amount of sewage that was in solution. The wells in this neighbourhood are a good instance of the truth of Dr. Frankland's opinion, given in one of his reports to the Government, where he says deep wells may become polluted by the access of polluted water through the fissures of the rock in which the well is sunk. The porous stratum through which the well is sunk may be so thin, that the water will be as much exposed to pollution as it would be if it were drawn from shallow wells.

In the water supply of Horfield, Bedminster, and other parts of Gloucestershire and Somersetshire, may be found samples of the water included in the third description. The liassic beds of limestone are nearly horizontal, and divided by stiff clays and schists, and form a very doubtful medium for a supply of good potable water. The surface is generally impervious to rain, and drainage impossible. The only exit for rain that has fallen upon and dissolved plentifully the organic impurities is between the limestone rock and the clay parting.

At Keynsham this state of things may perhaps be most easily seen. There the strata gently dip towards the N.E., and consequently the drainage flows in the same direction. On visiting the river Chew, that bisects the village, it will be seen that on the western bank are a large number of springs, while on the eastern not one will be found, and all the adjacent fields are full of water stopped back by the stiff clays. It is from this cause that the water of the surrounding villages is so impure from sewage impregnation.

The wells of the centre of Bristol and St. Paul's exemplify the last kind of water-bearing strata, namely, those that are both horizontal and porous. The centre of the city is composed of beds of sand, gravel, and peat, more than 200 feet in thickness deposited upon the coal-measures that reach the Mendips. They are so

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much below the level of the sea that they are always subject to tidal infiltration, bringing with it whatever sewage it may meet.

In the parish of St. Paul the ground is composed entirely of porous Kenper sands and marls that rest upon the Kingsdown millstone grit. They are so porous that if they are penetrated for making sewers, the whole of the wells in the immediate vicinity are drained. Indeed there are a great many wells that are quite dry, from a few having been sunk to a greater depth.

These brief details will give you some idea of the difficulties that Bristolians meet with in their search for pure water. Their general condition will be gathered from the following analyses of the water taken at random from some of the city wells, compared with the Company's supply:

Locality of Well.	Free Ammonia parts per Million.	Albumenoid Ammonia parts per Million.	Nitrates, Chlorine, Total Solids.		
			Grains per Gallon.		
Bristol Water Co.	0·00	0·03	0·06	0·05	18·11
Dighton Street	1·91	0·08	20·00	6·81	97·60
Queen Square	0·25	0·19	3·00	2·84	58·40
Ashley Road	1·45	1·62	18·0	2·27	81·00
Marlborough Street	0·35	0·95	20·0	8·50	128·46
Thrissell Street	0·25	1·72	20·0	7·95	123·24
Castle Green	0·15	0·68	18·0	6·81	122·80
Park Street	0·20	0·75	8·0	4·54	64·00
Christmas Steps	2·15	1·13	8·0	10·20	81·64
Pembroke Road	0·62	0·08	8·0	7·5	65·62
St. Paul's	2·25	0·12	10·0	8·42	79·21
Bedminster	0·19	0·73	15·0	8·62	80·00
Hotwells	0·40	0·86	8·0	5·69	68·26
St. Augustine's	1·55	1·34	30·0	16·80	130·40
Trinity Street	0·25	1·75	28·0	5·60	58·40
Regent Street	1·50	0·96	26·0	18·70	96·00
Small Street	0·13	1·65	25·0	10·48	60·80
Guinea Street	3·50	1·30	5·0	5·23	26·40
Kingsdown Parade	2·75	2·16	28·0	9·36	96·87
Horsefair	0·35	0·90	18·0	8·23	149·62

In consequence of the great want of good potable water, a company was formed in 1846, which after many struggles has succeeded in supplying Bristol and Clifton with an abundant and pure commodity; indeed few cities can boast of a finer set of reservoirs or plant. The water itself is brought nearly 20 miles from the Mendip Hills, and is therefore far away from the reach of human contamination or zymotic germs. From the calcareous nature of the watershed, the water contains about sixteen grains of

carbonate of lime or less, according to the season and time of year. This is a very moderate quantity when compared with that of Clifton. When, during a dry season, the Mendip source becomes straitened, the Company use a magnificent pumping-station at Chelvey, where the horizontal beds of the trias form a truly wonderful and gigantic filter. The Company is able to furnish all the water that can be required in the city for trade and household purposes.

DISCUSSION.

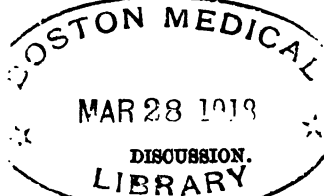
Mr. STODDART supplemented his paper on "The Water-bearing Strata of Bristol" with the following comments: The great diversity of the geological formation of the ground on which Bristol and Clifton are built renders the question of water supply a very important one; and I may say that had those gentlemen who yesterday adversely criticised the non-ventilation system of sewerage in Bristol been acquainted with the variety of dip, and the extraordinary facilities for the diffusion of gas through the city, they would have considerably modified their opinions. Scientifically speaking, this diffusion of gas was far more powerful than any pressure or any current through the sewers. The difficulties Mr. Ashmead would meet with are far greater than those of almost any other place in Great Britain certainly, and, so far as I know, than any other city in the world—the variety of dip is so tremendous. The map before me I may take by way of illustrating this. It is impossible to make one plan do for all; in carrying out the sewers you must take each part of the city by itself. The different configuration of the several parts of it is so complicated that I have been at work on geological maps of this neighbourhood for twenty-five years, and I have only just been able to form what I trust will be a correct idea of the country at the mouth of the river, at Portishead and the neighbourhood. We are making a tunnel under the Severn to connect one side of the Severn with the other, and to our great surprise we found coal-measures at the bottom of the Severn, where a hard roof goes across the Severn. And in making the docks at the mouth of the river here we expected to find that this roof of the tunnel would be at the base of the Channel Dock; but, instead of that, we found that there is a geological fault which has disturbed the bottom, and I suppose the bottom of the basin is 50 feet above the conglomerate which forms the surface over which the Severn runs upon the roof of the tunnel. That has disturbed us down here, so as to break up the whole country at the mouth of the river (Avon); and the old red sandstone, the coal-measures, &c., are thus all mixed up together in most utter confusion. I was engaged in inspecting the

country for water-works some time ago, and it is a fact that a well that supplies the water is in the old red sandstone; and close to it are the new red sandstone and limestone grit, about the width of this table apart—an upheaval which had taken place at the mouth of our river had disturbed them in that way. Recently, geologically speaking, the river did not go as it does now through the Clifton gorge, but through the Ashton Vale, which I will speak of by-and-by as an extraordinary aid to Bristol at the present time. If any of you should be going down the gorge, you will notice a road going from the river to the top of Clifton Down, which used to be called Windmill Hill—the “Observatory,” as we now call it. That is a magnificent fault. On the left-hand side and on the right-hand side the rocks for hundreds of feet have risen up on the easterly side and fallen down on the westerly side, and then been pushed against one another and turned then about, as it were. Below that the rocks dip to the south and south-east, but past that the whole country is turned round, and dips to the north-east. You can imagine how two or three such differences as these must add to the engineering difficulties of Bristol immensely. Even if there were nothing else, the lateral pressure of the tidal water is so powerful that in the lower parts of the city there are wells that contain water having in solution from sixteen to thirty-three grains of common salt to the gallon. Then in the St. Paul’s district the beds are horizontal and porous, and if you pump out one well you drain another. I one day found my well dry, and I ascertained that it was in consequence of my opposite neighbour at the Full Moon Hotel having sunk a well a yard deeper than mine, and it had thus drained my well. I then sunk mine two yards deeper, and drained his. We were consequently obliged to come to a mutual arrangement. The Full Moon proprietor and his neighbours agreed to sink their wells the same depth; but my well is as dry as a bone, and we could use it as a cellar. Having thus spoken of the great geological diversity, I might divide the strata into four groups: first, the inclined and impervious beds; second, inclined impervious beds with numerous fissures; third, impervious horizontal beds; and fourth, porous horizontal beds. As an example of the inclined impervious beds, I may mention Kingsdown and Brandon Hill, composed of impervious silicious rock, some of the beds being 12 feet in thickness, called millstone grit, and we recognise it as the base of the coal-measures; when the coal-miners come to that they give up all hopes of more coal. All

the water that comes through here comes *between* these beds as a matter of course. The beds of millstone grit dip to the north-east to the extent of 60 degrees. From Clifton, is a road coming down to the level; on either side of it are two wells very well known in Bristol. One well is in the division of one bed, and the other on the other side is in the division of other beds, but they are as distinct as though they were many miles apart, simply because they have got the impervious beds of millstone grit between them. These are used to supply many houses. Ten years ago there was a severe attack of typhoid fever in the same houses that in 1846 had the cholera. This aroused suspicion, and on inquiry it was found that these houses were supplied with water from one well, and those which had the water from the other were perfectly free. I examined both the wells. The constituents were very much the same; and there was no difference so far as chemistry could determine. I went and took a bottle out of each of them. It was clear, bright-looking water—very good water indeed as far as its physical properties went. Dr. Davies was with me at the time, and I said to him, "Here is a capital opportunity to prove your germ theory, because if the water supplied by this well gives the inhabitants of the houses enteric fever, you have only to take the dip of this clay parting, and it ought to carry you to a house that has enteric fever." And so it eventually turned out. It was found that there was at the top a house in which there was enteric fever. Although the proportion was so small that there was no free ammonia, no gases, or anything else, still it was a fact that they did trace the dip to the house in question; whereas the other well came up on to the surface of the Down, where there was no house at all. The other day a strange thing occurred in Bristol. There was an outcry about the water, and of course in my official capacity I had to examine the source of supply complained of. One was absolutely poisonous. It occurs in the same ridge of rocks about here (indicated on map) in Kingsdown, and was originally in the kitchen garden of the monks of a large priory, and was a large spring coming from the slope of the hill opposite, and giving them a very fine supply of water. The consequence was the city here a long time ago made it one of their public supplies. This water now absolutely comes from the same well, and has no less than eighty-one grains in a gallon; it is full of sewage, and has since been condemned by the Commissioners; thus it is shown that all the water connected with this rock I have

described must, as I say, go between the beds and not through the beds, which makes a great deal of difference.

For the last fourteen or fifteen years that I lived at the base of that hill I had a good supply of water, and I had the well enlarged after a time; but two months afterwards, the children said they wished I would look at the water, as there was a funny taste in it. To my great horror I found a lot of sewage in it. I went down the well with a man, and we could see nothing wrong there. I then took the dip of the bed, and made a section, and followed one of the beds right up to a house in Kingsdown Parade, and there found that one of our own aldermen was absolutely poisoning my well in a house half-a-mile away, by the excreta and refuse passing from his dwelling down between the beds which ran to the site of my well; and I had to stop it up and have the Company's water in. And yet you would say I could not have had a better place to dig a well—one which would be perfectly tight, you would imagine; but in this case there was a remarkable instance of the pollution of a well, because the water was not oxidized by going through porous strata and clays. That was a well which was a very fair specimen of any well in this city coming from the millstone grit, or, as I have called it, the rock dipping gradually and impervious to water. The second division which I have made is that of "the inclined impervious beds with numerous fissures." Illustrations of these we found at Stapleton, Fishponds, and a great part of Gloucestershire. The rock there is quite as impervious as the one I have already described, only it is very full of cracks and crevices, so that it fulfils the conditions exactly of that in Dr. Frankland's Sixth Report, in which he says, if you have a deep well in a fissured rock, it is equivalent to no more than a shallow well because the water comes in an unchanged condition. This is very common about the east of Bristol, and I should think if I had a hundred samples from a hundred wells there I should not find more than two or three fit to drink. The third division is where the beds are horizontal, but not porous. We find that in several places in this city these, as a rule, instead of dipping greatly, are horizontal. As an example, I can mention the neighbourhood between here (indicated on map) and Keynsham. Anyone coming from Bath here would notice frequently these rock strata, which are nearly horizontal and impervious to water. The water which comes from a well pierced in one direction (indicated) is always stopped by a bed of clay. This is so impervious that it seems



almost like puddling a pond-bottom—no water goes through it. The consequence is, if you dig a hole a foot deep, or a yard deep, it is full of water at once; and if you do not find it full of water it has run through some false joint or other into the bottom where the clay bed is. And as it dips only four degrees in a mile in this neighbourhood, you can regard it practically as horizontal, except that this little inclination makes a great deal of difference in the actual result. The beds, for instance, between here and Bath dip a little to the north-east. Here is the inhabited part, and there (indicated) is the country. It would be a folly to do any injury to the water running there—towards the village. If you put anything deleterious in that direction, towards the village, it would poison the whole of the wells in the village; whereas if you put anything likely to injure the water on the easterly side of the village you could not possibly do any harm to those wells. You can see practical instances of this at Keynsham and Saltford, and several other places alongside of the railroad, where the water can be seen dripping out of the bank. Then on the top level, beyond a house here (indicated), if you enter a quarry you can see the whole drainage of the house coming trickling out of these beds and going down into the quarry—hardly any goes through the drain.

The last strata which I have mentioned are the horizontal strata that are pervious. Here I would instance St. Paul's district, comprising sandstone, sand, and so on, but perfectly horizontal. It was here that my well was situated. If you can imagine old graveyards being there (which there are), and the water being bound to go through them, and passing through the sand 16 feet below the surface, you can imagine what effect it must have upon the wells, if you tapped, as they did tap some time ago, one of these beds in making a sewer, and they drained every well in the place. The head of this new red sandstone is against impervious rock, and for a considerable distance from Kingsdown almost to the middle of the city is this porous set of beds, of which the diagram before us is supposed to be a section. Then, again, if you go down into Queen Square the same beds lie upon the same rock, which afterwards reaches to the Mendips. The hill which you notice on the diagrams is Dundry, the church tower of which is very conspicuous, and is placed above the whole of these. But these rocks do not stop there; they go straight under to the Mendips. The coal-measures form the bottom of Queen Square. To make a lot

of sewers through these strata you must certainly have different kinds of sewers. The last set of beds I have to speak of is in the city itself, the lowest part of it. I do not think there is one single well in the whole of that district of which, if you said to me, "Shall I drink it?" I could say "Yes." I have a series of analyses there in my paper for your future guidance for purposes of comparison. I have twenty-one analyses taken at random from the city. The wells in this city are simply abominable; and nobody can stop them, because the hydraulic pressure in one direction and the lateral pressure in another are so powerful, especially if we have a high tide, which floods the strata underneath. Now if we ventilated those sewers we should certainly be drowned out. When you consider that our sewers are 20 feet below the common tide level and our tides rise nearly 40 feet, you can imagine the tremendous pressure that would absolutely drive the tidal water into our streets, and we should have to go about in boats. We really have a tremendous lot of difficulties to deal with. When I first came to Bristol twenty-seven years ago, if we had a heavy shower of rain, we had to get men with buckets to go down into our cellars, and we found two feet of water there. But since Mr. Ashmead altered the sewers we have literally not a drop there: they have been as dry as a bone. When I first came here we had to lay in a stock of cholera medicine every August as the year came round, which I dare say occupied us a month in getting ready. But since the sewers have been made English cholera has disappeared—we have hardly a single case of English cholera since. Some gentleman yesterday, when Dr. Davies was speaking about the germs of disease, mentioned the plague. The "plague" was no plague in Bristol; it was simply "English cholera." In the parish in which I lived during the greater portion of the time I have sojourned here we had had a lot of "burial books," and in the two years that we had the "plague" everybody had a big P in the burial books against them. They were buried in the lower part of the churchyard which is now a hay-market, because there is a popular prejudice about building houses over it. They say, "If you open that ground we shall have the plague again." The consequence is, it is now a hay-market, and there is not a house built upon it. A few years ago, for some sanitary improvements, we had to cut away a fourth of the churchyard, and this fourth was absolutely the place where these plague people were buried, but not a sign of the disease have we found. The parish of St.

James is covered over with that porous soil ; and though I think it is one of the dirtiest, still it is one of the most healthy spots in the city of Bristol, simply because the soil is porous. For many years before I came to Bristol I had the idea that the geological formation of the ground had a great deal to do with the health of the people, and so I find it has. Some years ago, when Dr. Budd was in his strongest health, I got a large sketch map and put a round dot over certain places, and the dots all accumulated on the alluvial soil so much—on the lias soil, which is quite horizontal in strata and quite impervious—and the dots there were so numerous, that we were obliged to cease dotting, as they were black altogether, in contrast with the porous soil, which was free from them. With all this danger in the city of Bristol, one cannot be surprised at the fact of a Water Company in 1846 being formed by some good men, and, in order to prevent any source of contagion, the source of supply is eighteen miles away—from the Mendips. The water can have no chance of human contamination getting to it, and it is brought in sets of pipes into Bristol ; and after a good deal of expense in the past, they have now succeeded in getting together some of the finest plant and machinery and supplies of water of any place in the kingdom. Of course there are places in the north where the supply is naturally quite free from lime ; but this being a limestone district, there are sixteen grains of lime to the gallon, and so far as the water goes it is absolutely pure. Dr. Tidy was down here the other day, and, testing it, he said that free ammonia in the Company's water was absolutely nil : when there is any it is from rainwater. When during a dry season the Barrow reservoir is dry, the Company use a pumping station at Chelvey, from a well sunk in a wonderful natural reservoir of triassic sands enclosed in solid beds of limestone. The Company have sunk wells of 200 feet deep, and every drop of water there is thus filtered through 200 feet of porous sands and clays. If they pump for twenty-four hours they will sink but one inch, and that is filled up in the morning. It is of itself the most perfect example of a natural reservoir of filtered water that I know anywhere. The reservoir itself is built of limestone, and its beds are horizontal ; and the only impurity which we have in the Company's water consists of the small, microscopic vegetables which live and grow on the edge of the reservoir. Of course, in the dry season these are dead, and the Water Company can wash them away. But if you filter the water, and examine it closely, you will find it simply silicious

vegetation, and nothing to do with sewage, or hurtful in any degree. It makes the water look a little muddy sometimes when they have been cleaning out the pipes and so on, but there is nothing hurtful in it; and we rejoice in a thoroughly good supply of water.

Mr. JAS. LEMON: There is no doubt that the information given to us by Mr. Stoddart is exceedingly valuable to an engineer, especially if he had the information previous to his laying out a drainage system, because it is ample data from which to lay down our levels. Mr. Stoddart made some reference to the remarks I made yesterday relative to diseases. I said, in reply to a remark made by Dr. Davies, that although we do not get diseases which he referred to now, in the earlier times we got diseases which were very much worse, and I alluded to the plague—the “great plague,” I mean, of two centuries ago—the London plague. We get now the cholera, which is simply a modified form of the plague, showing that the diseases have changed and have become of a lighter character. Reference has also been made to the germ theory. I am not going to set up my knowledge upon that subject against that of the medical men of this country. I believe there is a good deal of truth in it, and there is, at the same time, a great deal of humbug in it, and it is driven to excess. During the cholera epidemic in my borough the germ theory was set up, and we wanted to establish a hospital at the top of the town. The medical men came to the Sanitary Authority and objected strongly to the hospital being erected there. They said, “You have a water-carriage system; the cholera excreta will pass down the town and poison the inhabitants from above.” Through the representations of that deputation the Sanitary Authority abandoned the idea of a hospital there, and put the hospital lower down the town; but the medical men even then were not satisfied. Then they did not believe in your water-closet system, and we established dry closets, and supplied them with carbolic powder. These have been in use up to the last few months, but we have lately, upon another representation, taken them all away and substituted water-closets. This is only an instance of the extremes to which scientific men will go in pushing a theory. Then, Dr. Davies said that every form of disease must be generated—that there is no spontaneous growth; that, for instance, a man might live in a pig-sty and drink ditch water, but he would not get typhoid fever if no germs were there. Then I say we might as well drink of these bad wells which have been referred to at length by Mr. Stoddart. I

say that impure water has a tendency and does generate disease, whether there are germs or no germs ; and, although we are much obliged to Professor Tyndall and others for the immense amount of trouble they have gone to in investigating the sources of disease, I say they must not all be attributed to germs. Mr. Stoddart made reference to the ventilation of sewers, and said that in Bristol they would all be flooded out if they ventilated their sewers. But that has nothing at all to do with it. The drainage of Bristol is laid down upon a correct principle, in different levels. The high level districts are distinct from the low levels, and the high levels do not flood the low levels ; and therefore it is not likely to arise. Again, in the low level district during the time of high water the drainage must be stopped. When the level of the tide is above the level of the sewage in the sewer, of course there is no discharge, and the sewers during that time must be reservoir sewers ; and the tide is kept from flooding the low level by a proper system of self-acting valves. I do not see myself how the tide is going to find its way into the low level sewers. If it does, it ought not to ; and I am quite sure that Mr. Ashmead would soon take steps to prevent it, by penstocks or proper valves, and the considerable flooding which Mr. Stoddart alludes to could never arise. I believe in Bristol it does not arise ; and I dispute entirely that the sewers in Bristol are not ventilated. I say they are ventilated. If they are not ventilated, you must have a perfect connection with every house in the whole city, and that is impracticable. They must be ventilated in all the bad mains of the old city ; because this system, after all, is an intercepting system. The existing drains of the old Improvement Commissioners were picked up, and, of course, utilized wherever it was possible to do so. Of course, I should have done the same myself under similar circumstances. But no officer of any Sanitary Authority going into an old town can have a perfect knowledge of all the connections of the old sewers ; some of these connections must be faulty and are faulty. You sometimes get a dry system and your gullies give trouble. In my borough I am obliged to send round water-carts and fill all my gullies up where there is bad ventilation. These alone are sufficient to offer an outlet for your sewage gas during dry weather, and I have no doubt that the gases from those sewers do find their way out at various points. I say, when that is so, you ought, I think, to have a proper system of ventilation, and not to leave the sewer gas to get out "on the sly."

Mr. ELLICE-CLARK: We are much obliged to Mr. Stoddart for his very valuable paper, and the speech he has made with reference to the diagrams upon the wall. And if most of us had a gentleman in our towns so conversant with the geological formations of our districts, it would materially assist us in carrying out water-works and sewage-works, more especially if they would come forward as willingly as Mr. Stoddart does and make public their knowledge, extending over so many years. I should be glad to know if Mr. Stoddart can give as any information upon the extraordinary theory ventilated by Mr. Baldwin Latham, at the last meeting, I believe, of the Social Science Congress, or the Institution of Civil Engineers, that when water in a river had been polluted by the sewage of a town it was rendered innocuous by oxidation. I have seen it stated that there is no river in England long enough to thoroughly purify sewage by oxidation, but I have never seen Mr. Latham's theory thoroughly refuted. I should like to have from Mr. Stoddart some information on the subject.

Mr. LEMON: I think we ought not in the course of the discussion to omit a vote of thanks to Mr. Stoddart, and I have much pleasure in proposing a vote of thanks to him for his paper.

Mr. PARRY (Reading): I second the proposition. I think Mr. Stoddart's remarks are very useful. There are few cities and towns provided with such ample information upon the subject as Bristol appears to have been; and I have no doubt that, if so much information was known to Mr. Ashmead before he laid out those drains twenty years ago, he might have been influenced by it to a great degree.

Mr. STODDART: I generally aim at telling anyone anything I can. With regard to the ventilation, I cannot pretend to give you any information, but I can say that no sewer can by any possibility in this town prevent the extraordinary pressure of the water. With regard to zymotic disease, you will of course remark that it is a blood-poisoning disease. Our habit of living now is different from what it was twenty years ago, and consequently we have a different set of diseases; and another item to be taken into account is the advance of medical education, and what a person is believed to die from was formerly put down to many other causes than those to which it is ascribed now. With regard to the germ theory, I am not going to advocate it, because there appear to me to be six on one side of the question and six on the other. We had, however, a very curious confirmation of this theory with regard to two

wells. Dr. Budd and I went down to those wells; one was on the right of the road and the other on the left; and we were stopped in pursuing the theory by the apparent fact that the houses the inhabitants of which were affected were supplied out of the wrong well—the well that could not be contaminated; and that the houses the inhabitants of which were well were supplied from the well in which the germs of enteric fever were. “Now,” I said, “here is a dead-lock; we cannot go any farther.” But three or four months after this, for some other reason, the plans of the city were shown in which those wells occurred, and, to Dr. Budd’s intense surprise and delight, these water supplies *crossed* under the road; and it was a fact, therefore, that the infected houses were supplied from the contaminated well, the course of which crossed—as nobody had been aware of at the time—under the road, thus accounting, in a very easy way, for the difficulty we had found. With regard to the water-closets being changed for earth-closets, there is one thing which we should bear in mind; the earth-closets answer very well, and a large establishment in this neighbourhood has a lot of earth-closets, and men were employed to put the excreta over the ground elsewhere. But the rains, soaking through the earth and excreta, have washed them into the neighbouring ground, and poisoned all their wells. And it is a question in my mind whether any irrigation by sewage could possibly do for us effectually in this neighbourhood. An acre of ordinary ground—clay will do with 50,000 gallons of sewage, but in the neighbourhood of Stroud, Bath, and all along the Cotswolds, an acre does for 100,000 gallons; and it is the only instance of the precipitation process of sewage that I know of anywhere here which in every degree answers. The precipitation I introduced myself, and sold a great many tons, which were sent to the West Indies for manuring sugar; and I dare say they continue it now; but at the same time I unhesitatingly think that the value of sewage is enormously exaggerated. The sewage collected in the neighbourhood of Stroud had a moderate proportion of nitrogen, and only half per cent. of phosphoric acid. The nitrogen was found to be mainly due to the presence of human hair. Strange to say, the mud produced by the precipitation process was full of hair, and we consider that all the nitrogen we got came out of that hair. With regard to the oxidation, we have in sanitary chemistry worked at it a great deal for some years. Of course the Bath sewage goes into the Avon, which formerly was a salmon river. On testing the

water at Netham, twelve miles from Bath, the sewage is found to have disappeared in a great measure. I think Dr. Letheby advocated the theory of organic matter disappearing under oxidation. But it, at any rate, is a fact that a lot of sewage is turned into the Avon, at Bath, and when we test the water, say at this point, near Keynsham (indicated), where we have worked most, there is very little found. The difference between the Avon water at Bath and the Avon water at Keynsham is very distinct. It is much better down here than it is at Bath ; so it must disappear somewhere, and most likely by imperfect oxidation.

A SHORT DESCRIPTION OF THE SOURCES OF SUPPLY AND PRINCIPAL FEATURES OF THE "BRISTOL WATERWORKS."

By H. M. PEARSON, C.E.

THE sources of the water supply for Bristol are principally situated in the Mendip Hills near Chewton Mendip, Somersetshire, but there are also other sources situated at Harptree, about $2\frac{1}{2}$ miles from Chewton; also at Barrow Gurney, about 5 miles from Bristol; and at Chelvey, near Nailsea, about 9 miles west of Bristol.

The source of supply at Chewton is derived from springs in the limestone, which are united underground and conveyed by branch aqueducts from the collecting tanks to the main aqueduct, which passes through the parishes of "Chewton Mendip," "Litton," "East Harptree," "West Harptree," "Compton Martin," "Chew Stoke," "Winford," and "Barrow," discharging itself at the mouth of the Winford tunnel into the store reservoirs at Barrow.

The main aqueduct is constructed "partly of masonry, in some cases driven through the solid rock, without a lining of masonry," partly of iron pipes laid undulating through the hilly country, partly of iron tubes spanning the valleys, making in all a total length of about 11 miles.

The size of the aqueduct varies from 4 feet $7\frac{1}{2}$ inches \times 3 feet 6 inches to 7 feet \times 6 feet, and is of an oval section.

The wrought-iron tubes spanning the valleys are rather an interesting feature, being mounted upon friction balls resting on cast-iron saddles to allow for the expansion and contraction due to change of temperature; the fall of the aqueduct is for the most part 1 in 1056.

The store reservoirs at Barrow are two in number, and have a water area of 67 acres. From these reservoirs the water flows by gravitation through Bristol and into the Oakfield Road reservoir at Clifton, from whence the water is pumped to the high level reservoir upon Durdham Down, Clifton, a lift, including friction,

of 140 feet; from this reservoir the Clifton District and neighbourhood are supplied.

There are also two compensation reservoirs at Sherborne, near Litton, constructed by damming up a portion of the valley of the Chew, from whence water is discharged for compensating the mills situated upon the Chew river, the Company being compelled by their Act of Parliament to deliver a certain quantity per diem.

There is another reservoir of the same description at Chew Magna in connection with the tributaries of the Chew.

The Sherborne reservoirs have a water area of 24 acres; that at Chew Magna, a water area of 9 acres.

At Bedminster there is a reservoir and pumping-station, from which water is pumped for the supply of Leigh and Knowle.

The supply of water at Chelvey is derived from springs and wells in the new red sandstone formation, and is a very large source of supply which is being greatly extended.

Here there is at present 130-horse nominal pumping power, which lifts the water either into Bristol or to the store reservoirs at Barrow as required; this pumping power will shortly be very much increased.

The Company's limits of supply not only embrace the borough of Bristol, but also a very considerable district outlying the borough boundary.

The consumption per head of the population supplied is $21\frac{1}{2}$ gallons, including supply for all purposes.

SOME POPULAR ERRORS IN CONNECTION WITH SANITARY MATTERS.

By DAVID DAVIES, M.R.C.S., MEDICAL OFFICER OF HEALTH
FOR BRISTOL, &c., &c.

GENTLEMEN,—It is no light task for the member of one profession to read a paper before the members of another when met together for the exchange of ideas and the advancement of their profession. I have ventured to do so at the request of your much-respected *confrère*, Mr. Ashmead, our Borough Engineer, whose colleague I have been for many years as one of the officers of this city.

As our respective professions meet at many points, and occasionally overlap one another in sanitary matters, I will endeavour to bring before you certain views which may prove interesting to both professions.

The first point for a military commander on active duty to do is to ascertain accurately the number, nature, arms, supplies, and mode of attack of the enemy. So ought it to be with those who are engaged in advancing sanitary science; but, unfortunately, here vague traditions, superstitions, and unpractical hypotheses, too frequently have taken the place which ought to be held by accurate information and scientific deduction.

The most powerful and numerous enemy of the human race is the so-called zymotic group of diseases, the deaths from which form a very large proportion of the total mortality: to these then we will turn our first attention. Here at the very threshold of our inquiries we meet the

Pythogenic theory, which more or less in different minds attributes the origin of these diseases to dirt and the putrefaction of organic matter, instead of to an unknown infectious organic poison, which, once introduced into the human system, under certain conditions, there reproduces itself, and spreads its seeds according to determinate laws which may and have been ascertained, an organic entity of the mysterious origin of which science knows nothing, but history a good deal. I do not stand here as the advocate of dirt,

which is only matter out of place: but a trite English adage says that a certain personage may be painted too black; so I think of dirt. All zymotic diseases have been, and now frequently are, attributed to it, whilst the true cause of this class of diseases is overlooked, and the proper means for abating them are therefore neglected. According to a numerous class of sanitarians, to wash and be clean is sufficient to prevent disease and prolong life; for example, a truly celebrated philanthropist with these views thus writes:

"I have seen with my eyes, and smelt with my nose, small-pox growing up in first specimens either in close rooms or in over-crowded wards, where it could not by any possibility have been caught, but must have begun.

"Nay more, I have seen diseases begin, grow up, and pass into one another.

"I have seen, for instance, with a little over-crowding continued fever grow up, and with a little more, typhoid fever, and with a little more, typhus."

This quotation is from a very popular work. With such views abroad, our fight against the deadly zymotics is a very feeble one. A little philosophical consideration of facts in the history of our race and zymotic diseases would soon dispel these baneful delusions. The Red Indians of America had revelled in their filth, and slept in their close unventilated wigwams from time immemorial when the white man invaded their territory, yet small-pox, measles, typhus, and typhoid fevers, and the other zymotics, had never appeared among them until the white man carried the seeds of these diseases to them: history records the terrible results.

The Fiji Islanders had never by neglect of personal cleanliness developed measles, which was unknown to them until the germs of this disease were carried to them in a British ship, on board of which I feel assured the strictest order and cleanliness were observed.

Small-pox, known to the Chinese a thousand years before the Christian era, was never developed in ancient Europe; was unknown to the Greeks and Romans, and never invaded Europe until the year of the Hegira, when it was brought from China into Arabia, and thence into Europe. We have no reason to believe that the ancient nations of Europe were cleanly in their habits, or that they slept in well-ventilated rooms; yet this disease as well as scarlet fever—the pest of modern days—was never developed among them. This latter disease was unknown in Europe until the

middle of the seventeenth century, when it was imported from the East into Italy, and thence to the rest of Europe.

When the rinderpest was first imported into England, this class of sanitarians did their utmost by their false theories to favour the spread of it; according to them, it was not a foreign disease imparted from the Continent, but a thing of home growth, the natural outcome of the filthy condition of the London dairies, and the bad food given to the cattle. If these false theories had been considered sufficient to account for the plague, and measures to meet *them* only adopted, neat cattle would ere this have become extinct in England; but the government of the country, wiser generally regarding the pockets of the people than their lives, soon discovered by means of a commission the nature of the disease, and adopted prompt and decisive measures for its extinction. Then you may naturally ask, How does this concern you as engineers, and why should I trouble you with these medical theories? This point, Gentlemen, concerns you very closely, observation and experience have shown that this group of diseases have respectively different laws for diffusing their seeds, different periods of incubation, maturation, and convalescence; we find that their striking distances vary, some of them in this respect being what may be called long range, and others short range, diseases, and so forth. It is to you, Gentlemen, that our profession looks for material assistance to meet these conditions, and so to abate and finally to annihilate these zymotics.

It is well known that enteric fever (typhoid) and Asiatic cholera shed their seeds by means of human excreta; that these seeds have a wonderful vitality unless destroyed by the application of chemicals; that if thrown into the common sewers, they will thence frequently penetrate through thick layers of earth or rock, and poison wells of water used for domestic purposes; that occasionally, when these sewers have open communications with houses or confined spaces, they will thence issue in a volatile form and destroy life; that in the form of a dry powder in dried excreta they can retain their vitality for an unlimited period: this is supposed to be one of the common modes of the diffusion of cholera in India, and I believe it is often the mode in which enteric fever spreads in England. For example, suppose an unpaved court in which young-children are allowed to play in the middle of a crowded population; now it happens that although young children are very liable to contract this disease if exposed to the infection, they

very frequently take it in a very light form without confinement to bed, the chief symptom of the disease being a little feverishness towards evening, which caused the last generation of practitioners to call this form of the disease infantile remittent fever. The affected child during the earlier part of the day plays with other children in this unpaved court, diarrhoea being a constant attendant of this fever; the child relieves himself on the unpaved filth-saturated soil of the court; the seeds soak into the soil; a hot sun dries them, they are then blown about and disseminated far and wide: this is not an overdrawn case. With a view to remove such a source of danger, the Sanitary Authority of this city have had all public courts paved and channelled.

Then the nature of typhoid fever and cholera, and the manner in which they spread being known, it is for members of your profession to point out to us the best method for removing the chief source of them, viz. human excreta, to strenuously oppose, or safely modify, any plan proposed for this purpose that may tend to scatter broadcast the infectious seeds, whether in the form of fine dust or as invisible germs poisoning the watersheds of the country. In speaking thus I have no special plan in view, but I know of many that deserve more careful examination before they are accepted as unexceptionally safe. Although I am myself of opinion that water-carriage is the best method, if not indeed the only one practicably applicable to large communities of a mixed population like that of this city, I consider that other methods, equally safe and much more economical, might be adopted for smaller communities more thinly spread.

Again, one of the most popular and attractive questions in Sanitary Science is how to house the people? It has for a long time, and still does engage the attention of legislators, architects, engineers, medical practitioners, and a whole host of warm-hearted philanthropists, yet I conceive that very serious blunders are being committed in connection with this subject in the present day, mistakes which a future generation will rue and will have to remedy. As this is a very serious view of the case, I am in duty bound to lay before you the premises on which I have formed that opinion. All statistics of mortality tend to prove that with equal conditions, the number of people on an acre bears a direct ratio to the returns of mortality. Our experience of small-pox and maculated typhus has shown them to be long-range diseases whose striking distance is very great. Our experience of typhus fever in Bristol in 1865

was that if introduced into the lower part of a large house containing many families in separate apartments, it almost invariably ascended and affected every compartment above the room first infected before it was extinguished; its infecting seeds are evidently light and volatile, and have an ascending power. We have found that different families having privies or privy landings or corridors in common, generally have their diseases in common, especially the two last mentioned, viz. small-pox and maculated typhus, the seeds of which are most readily communicated by means of clothing, and, from facts known to us, are for some time floating in the atmosphere surrounding a person whose clothes have been exposed to infection.

My own observation of human nature leads me to believe that every plan which involves any approach to communism in domestic life has a deteriorating influence on those subject to it. A man loses much of his self-respect when he loses his patronymic of John Smith or John Brown, and becomes known as No. 22 or 30. Man never rises higher than when isolated in families in separate cottages with separate household offices, and separate plots of garden, or court, as the case may be; he then feels his responsibility, and, if by race a true Anglo-Saxon, repudiates any leading-strings or inquisitive superintendence. The Celtic races, owing to their more warm, friendly, and gregarious nature, may possibly adapt themselves to modern views of artisans' houses, much more readily and beneficially to themselves than those with more Teutonic blood in their veins; but even in such a case a very heavy responsibility of constant sanitary arrangement must rest on some able and efficient superintendent, whose very beneficent actions will destroy the self-respect and self-reliance of the superintendent.

The frequent prevalence of maculated typhus in the flats of Glasgow and the almost insuperable difficulty in efficiently dealing with it owing to the nature of the buildings, although undertaken by one of the most energetic, intelligent, and persevering sanitary committees in the world, aided by most able and experienced officers, ought to have served as a warning against the adoption in the southern parts of the island of the errors and misfortunes of our northern brethren.

I have thus stated the facts on which I have based my views of popular errors in the modern attempts to house the people; it now becomes my duty to state those views candidly and in detail. I do so with hesitation, and with a full sense of the responsibility which

I incur, conscious that in doing so I am exposing myself to the keen criticism of a most able press; that I traverse the self-chosen path of zealous and disinterested philanthropists, that I may in doing so possibly damp the hopes and chill the ardour of good men who have made this the favourite study of their lives. Contrary to the usage of ordinary culprits, I must, previous to the commission of the offence, plead reasons for arrest of judgment. I have no motive but the chief object of my labours, the health of the people. I have nothing of a personal nature to gain or lose by my opinions. I am not a mere amateur seeking for notoriety, but have been for the last twelve years in the thickest of the fight, and have without fear or favour, except the constant and indulgent support of the Sanitary Committee of this city, fought the sanitary battle of this large community on these lines. Then let me to the point. I am of opinion that all so-called model lodging-houses, if so arranged as to multiply the number of inhabitants on an acre, or place different families on floors, or as I should call them flats, one family above another; or by corridors, common areas, common passages, whether separated by pervious iron railing or not, or have offices in common for washing or other domestic duties, or in any other way approach a system of domestic communism, are an error and a blunder; that in such constructions the facts which I gave in detail as premises to my conclusions, have been ignored; that such houses at some future period, when the present almost parental supervision will have been withdrawn, the careful selection of inmates given up, and as a consequence the nomadic population of our large towns will have found an entrance; will then become the chosen homes of typhus and other long-range zymotics, and I am doubtful if such an unhappy consummation will be deferred until then. If these views be correct, much of the much-vaunted work of the present generation will have to be undone by the next.

With strict selection of inmates and careful supervision, and with all the machinery new and in good order, a low death-rate may and ought to be shown in these houses. The same is the case in the public prisons of the country. Conclusions founded on statistics depend on the manner in which they are read, and the analysis to which they have been submitted. Statistics of health and mortality taken from any community, if that community is not a representative of the average age, of the moral and social condition, and of the precarious mode of subsistence of the mixed

population of a large town, must lead to hasty and wrong conclusions; by taking the statistics of the family history of the persons now admitted into these houses for five years previous to their admission, or by taking the statistics of a similar class not yet admitted, I think it very probable that equally favourable figures would be the result. Having said this much by way of caution against prevailing opinions, you may naturally ask me what I propose to substitute. I will briefly do so. My idea of an artisan's house, calculated to promote moral as well as physical health, is as follows:—

The ground must be well drained both as regards the surface and the subsoil; because it is an ascertained fact, that tubercle of the lungs (phthisis) is very prevalent in houses built over a damp subsoil.

The house should not be more than one story high, and contain no more rooms than would suffice for the decent lodging of a husband and wife and an average family of five children. It should contain one room for the isolation of one or two sick children. The walls on a level with the surface ought to have one course of material impervious to wet, so as to prevent dampness above by capillary attraction of the soil. It should, as a sailor would say, be ventilated "fore and aft." It should have proper offices for domestic and other duties at the back of the premises. The courtyard and all the surface not cultivated as a garden ought to be scrupulously paved or pitched. A loose soil surface not cultivated as a garden, and over which children are allowed to play, forms a most ready receptacle for the germs of typhoid fever, hence the frequent prevalence of this form of fever in newly-built streets in which the courts and surrounding surface have not been paved. Of course it should have good drains, and be supplied with good water. The connection with the drains ought to be carefully put outside the house, so that sewer gas, with its contingent danger, could never enter the interior. The ground-floor ought to have cross ventilation underneath. All the floors should be so carefully jointed as to prevent any noxious ingredient getting between the ceiling underneath and the boards. This space, where the floor is imperfect, is by careless housekeepers frequently made the receptacle of foul matters full of the germs of disease. We have very recently in this city, under proceedings by the Sanitary Authority on my information, seen two large cartloads of most foul and stinking matter, the refuse of the family for years, removed

from such a space. The matter was so arranged in layers that if preserved some future archæologist could by examination of it read a considerable portion of the domestic history of Bristolians during the last decade.

Such, Gentlemen, are the leading points which I hold regarding artisans' houses. Our towns loudly call for dispersion and not concentration. Our working classes require proper self-respect, personal and family individuality, self-reliance, and a sense of responsibility cultivated in them and not destroyed.

Houses more or less answering to the above description have been of late years built in large numbers in the outskirts of Bristol, by means of which the city has been spread and decentralized. A deputation from the Sanitary Committee of Glasgow, when visiting us some years ago, admired the manner in which the population was being spread and not centralized; and they expressed a fervent wish that they could follow our example in their city, but that various conditions rendered it impossible there.

A very popular and, as I believe, delusive opinion is that a further improvement and extension of public sanitary measures such as are, or might be, put at the command of a Sanitary Authority, if it could not altogether remove the doom pronounced on our race, "Dust thou art, and unto dust shalt thou return," still might prolong human life to the longest possible period. A truly eminent member of my own profession, with a most fertile and poetical imagination, and with that brilliant command of modern Anglo-Saxon which places all ordinary writers in the shade, has laid before us such a picture of a sanitary city as he conceives ought and might be established, that ordinary observers like myself, at the first perusal of this great idyllic poem, are apt to be carried away with admiration, first, of the powers of the writer, and secondly, of his great faith in humanity and hopes for its future; but on calm consideration I found my feelings much akin to those which affected me twenty years ago after reading the transcendent lucubrations of one of the greatest of French writers on a possible religion. In both cases I saw before me a gorgeous temple perfect in all its proportions; from the lowest foundation to the topmost pinnacle all was complete: but I could see no worshippers. There was laid out a garden of Paradise, with its fruit trees, pleasant walks, and purling streams, but I could see none worthy to enter. Outside the gates was a miscellaneous

multitude, descendants of the original couple who desecrated the first Eden, but

“The trail of the serpent was over them all.”

It is not by such speculative flights of human fancy that our sanitary condition can be advanced, or the rate of mortality reduced. Let us, then, take a practical view of matters as they really are and endeavour to remove existing evils. The excessive mortality amongst us occurs chiefly in children under five years of age. The total deaths in Bristol during the year 1876 were 4491. Of these 2016 were the deaths of infants under five years old. After careful analysis of the returns I am of opinion that but a very small proportion, if any, of the excess here was due to faulty sanitary conditions that might be remedied by public authorities. The real causes, as I conceive, are the following, which I will mention in the order in which I consider they operate:—

1. The complete ignorance of the mass of the people of the first principles of political economy, and their obstinate resistance to all efforts to teach them this science, which shows the same rigid connection between cause and effect as any of the physical sciences.

2. The self-imposed poverty arising from not adapting their expenditure to their average receipts, and wasteful extravagance during prosperous seasons and high wages.

3. Reckless and improvident marriages, and the production of children by parents who have neither the means nor the desire to take proper care of them.

The suffering and death arising under this head are simply heart-rending. Hundreds of children in this rich city sleep by night without any covering but the tattered garments which cover them by day, their only bed being either bare boards or a bundle of shavings; they are dragged, not reared, into life by unwilling parents, who view them as burdens and hindrances to their own sensual gratifications. When such zymotic diseases as scarlet fever, measles, or whooping-cough sweep over the poorer districts, you may see children in every stage of these diseases in the open courts or streets playing or nursing one another. In one court you may see a child racked with the convulsive throes of whooping-cough and exposed to a keen east wind: that child will probably die of congestion of the lungs or brain in forty-eight hours; in another you see a convalescent from scarlet fever, who will probably

die of acute inflammation of the kidneys; or you may see a convalescent from measles, who will shortly die of inflammation of the lungs. The seeds of infectious diseases are also thus sown broadcast over the city. To convince persons who have no love for their own children of their duty to regard the welfare of other people's children would be impossible. The penal clauses of the Public Health Act cannot practically be applied to them, except in a few cases. To take before our magistrates the parents with their personal clothing saturated with infection would be to endanger the lives of our justices, and possibly to clear the bench of its appointed occupants. I have seen these people enter (as tenants) clean houses, and I have known them convert them into dens of filth in a month's time. I believe that if they were housed in the Mansion House of this city they would do the same. When their children are seriously ill, and the disease has made too much progress for benefit to be derived from medical aid, they will then procure medical attendance, so as to secure a certificate of the cause of death and avoid the suspicion attached to a coroner's inquest.

With such a social condition, too common in our midst, I have known a change of wind from south to east, when measles and whooping-cough were epidemic in the city, to raise the rate of mortality from 25 per 1000 per annum to over 40 per 1000 in one week. The figures appear in due time in the Registrar General's returns, then learned articles appear in reviews with severe comments on our general sanitary condition, which, so far as the Sanitary Authority and their officers are concerned, had nothing to do with the excessive mortality.

I have thus, Gentlemen, in feeble terms pointed out the chief cause of this mortality, viz. the ignorance of the people on matters appertaining to health and their social habits. I have shown that the returns of mortality taken as a whole and without analysis do not indicate the general sanitary condition of the districts, as they are dependent upon the action of public authorities under the Public Health Act; but they indicate THAT, plus the social habits of the people, plus, as a controllable factor, meteorological influences.

Sanitary Authorities and the Local Government Board are powerless against the evils arising from the social habits of the population. I have been anxiously expecting the three great teachers of the public, viz. the Press, the Pulpit, and the Political Leaders, to take

up the subject, and, in the spirit of the Hebrew prophet, say to the guilty parties, "Thou art the man;" but I have looked in vain.

With regard to healthier theories of the principal diseases among the reading classes, and especially among those engaged in sanitary matters, there is hope of a brighter day. The trenchant writings of our former fellow-citizen, Dr. Budd, whose name will ever remain a brilliant star in sanitary science, although now himself unhappily prostrate with sickness, are gaining daily in their influence. The masterly reports of Mr. Simon, C.B., lately medical officer to the Privy Council, are extensively studied. The scientific researches of Tyndall on dust and disease, putrefaction, fermentation, and kindred subjects, to which may be added the invaluable work of Pasteur on diseases of the silkworm, have removed from the minds of many members of the medical profession the superstitious dread with which they regarded the theory of the specific origin of infectious diseases. Professor Lisher, of Edinburgh, has established the fact that the germinal theory of disease is as applicable to surgery as to medicine, and the reports of Dr. Ballard and others on contaminated milk have shown that typhoid fever is a regular unit of the zymotic group.

Dr. Carfield in the metropolis is doing good work by delivering public lectures on such matters, which cannot fail to produce a most beneficial result. Gentlemen, the sky seems clearing in all directions but one. Oh! that some one could raise to the beauty of human life the lower stratum of the population of our large towns; that some one could lay the animal and raise the man in them, then, and not till then, shall we see the excess of mortality disappear from our midst.

It was my intention to allude in detail to some popular errors regarding the ventilation of sewers; to point out the cases in which it is superfluous, if not injurious; to show where it was absolutely necessary, but time will not allow me to do so; I will simply point out what appears to me to be the chief requirement of the day under this head, viz. a legislative enactment against all direct communication between the interior of houses and the sewers, *i.e.* every connection between the sewers and the communicating drains should be made in an indirect manner outside the house. This would remove almost all danger arising from defective traps, and the chief objection to the water-carriage system for sewage.

I had also intended to say a few words regarding the contamination of water used for drinking purposes, and to point out that the

danger indicated by contamination was not in proportion to the quantity of organic or inorganic matter contained in it, but was dependent on the source of contamination, which in this country was generally human sewage ; that the slightest indication of this source was always a sign of danger ; but that even this danger was contingent and dependent on the introduction of the germs of disease from a suffering patient ; but these matters I am compelled to dismiss with a simple allusion.

In conclusion, Gentlemen, I may plead in extenuation of any shortcomings on the part of your profession and mine in sanitary matters, that we are the first generation of sanitary officers, that we shall have done good service if we brush away false notions, which like cobwebs have clung to this youngest and most promising of the sciences ; and if having lighted our own lamps, although their light be feeble and flickering, it may be said of us when we depart :

Λαμπάδια ἔχοντες διαδώσουσιν ἀλλήλοις.

DISCUSSION.

The PRESIDENT: We are much obliged to Dr. Davies for the very interesting paper he has read, and I shall be glad to hear any remarks any member may wish to make upon it.

The Rev. L. M. Hogg: May I venture to call very brief attention to what Dr. Davies said of Professor Tyndall's discovery respecting the deleterious effects of dust? I was stopping last summer in Germany, close by a large Bohemian glass factory, and I could not help being struck, on going carefully over the works and talking with the men, when I heard them say, "We are all doomed men soon after forty; if one lives to fifty he is an old, worn-out man." I recollected Tyndall's great lecture, in which he showed us that if we could only breathe through cotton wool, and sometimes cotton wool sprinkled with glycerine, it would effectually stop every deleterious particle of dust entering the lungs. Some of you come from Birmingham, Sheffield, and other places, where the steel grinders and others work, and where the particles get into the lungs of the workmen. I wrote to Professor Tyndall upon the subject, and asked him if his invention were put into a practical shape, and I find that it is. I want simply to do what he asked me the other day in London. He said, "I should be glad that the application of this invention should be carefully watched in steel, glass, and all such factories, and paper mills." Those of you who have been in these factories must have seen that a respirator would be of great use. There is one process in paper-making in connection with the bleaching which is so bad that you and I could not probably stop in the room more than one minute, and yet the workmen are obliged to remain there half an hour at a time. They use handkerchiefs over the mouth, but that is a wretched protection; and a master once said to me, "One of my men dies in twelve years, another in fifteen, and so on." The respirator I speak of would be effectual. And if any of you should be passing through Leadenhall Street, London, No. 104, and will call at Mr. Sinclair's, he will show you Professor Tyndall's invention put into practical shape. The respirator should cover the nostrils and mouth, and if properly used and the cotton changed

daily, it will effectually stop the injurious action of the minute particles in these branches of work. I would ask you to look at the question in this simple, practical way. You are going to the banquet to-night; and when any of us sit down to a well-spread table we doubtless like to see good cutlery, bright glass, and a nice service; but is it not painful to reflect that at the present moment we are purchasing these comforts and luxuries literally by grinding away in the most literal sense from twenty to twenty-five years of the lives of the men who make them? I ask you to look at it in this light, that that loss of life is surely preventible if we get the remedy into use, as fire-damp dangers are preventible by the use of the Davy lamp, or as small-pox is preventible by vaccination. I would have you make known that there is this remedy, and especially bring it before the attention of gentlemen in any way connected with glass-factories, steel-grinding, and paper-mills, and anywhere where dust is introduced into the lungs in the way I have mentioned, and make known to them Professor Tyndall's invention; and it is with this object that I have sought to put you in the way of getting these respirators.

Mr. H. P. BOULNOIS (Exeter): With regard to the germs of disease referred to in Dr. Davies' paper, I should be glad to know whether the germs would be killed in any other way than by heat or disinfectants. He tells us it is a difficult thing to kill these germs; is it possible in any other way than by heat or disinfection? Then as regards artisans' dwellings. I should like to know whether it would be possible to do what he suggests—viz. attempt to spread the population of a large city in one-story houses. There are, of course, cases where it would be utterly impossible; and is it not better to put such a population in high-built dwellings, on flats, with all the latest sanitary inventions and improvements, dust-bins to carry the dust down a shoot, proper privy accommodation, and plenty of air and ventilation? Is not this better than the rookery to which the artisan sometimes removes? We say that we must adopt the best means we can to prevent overcrowding and unwholesome dwellings, and the best means that have been found hitherto have been the erecting of buildings a great height; but Dr. Davies would tell us the best means would be to have houses of one story only. It would take an enormous area to do what he proposes to do in a crowded city. I should be glad to have some suggestions that would be more practical than that of spreading houses of only one story in height over a thickly populated area.

Mr. ELLICE-CLARK : We are all indebted to Dr. Davies for his elaborate paper, more especially as it comes from a gentleman who for twelve years has been working away to lower the death-rate of this great city. It would be captious, if not impertinent, for me to attempt to criticise the various matters that Dr. Davies has brought forward ; but I do think that the spreading out in this way of the inhabitants of large cities like Liverpool, Manchester, Bolton, and other great centres of industry, is an impossibility. Employers of labour are constantly saying that they want to have their labourers near their work. Take Liverpool, for instance, with its vast number of dock labourers ; if these people had to be housed in dwellings of only one story, it would be quite impossible for them to get to their work in proper time, and they could not do in the requisite time the amount of work required of them. Dr. Davies truly says that the statistics given of artisans' dwellings are not founded upon right premises. I myself have taken some trouble in going into those places in London (the Model Dwellings), and I found that the people who live there are not the particular class of people (the poorest people) who require to be carefully housed. The class of people inhabiting the Peabody dwellings, for instance, are the respectable poor, and not the very poor ; whereas it is the very poor, the poorest people, that you require these places for. Another point Dr. Davies has mentioned strikes, I think, at the root of the matter. I alluded to it in a paper at the Social Science Congress last year—I mean the subject of the sanitary education of the people. Last year, in the course of preparing a report for the Derby Artisans' Dwelling Inquiry, I went inside 2800 houses inhabited by what I call the "very poor," most of them living in close confined courts, leading out of close confined streets ; and the pictures of abject poverty, filth, and dirt, which I saw there I could hardly believe could have existence in any city in England. The condition in which they lived seemed to overpower nearly everybody who was living there, and they seemed as if they could not possibly rise out of the filth and mire amongst which they were living. I do not know that Derby is different to most of the towns similar in age to itself. It is not a water-closet town, and there the open privies adjoin and actually form part of the dwellings in many places. Near twenty or thirty houses in one court there are five or six of these open pools running at the gable end of the houses, and the pools in many cases actually go beneath the houses themselves. Of course, that is an artificial state of things that the sanitary engineer would do

away with; but before we can do away with it we have not only to educate the working classes, but to educate the Sanitary Authorities, to the great duties imposed upon them. To remove all these open privies in Derby and in other towns would cost a large amount of money and a large amount of trouble. They have been trying for many years there to introduce other things in place of the open privies. They have tried to introduce the "tubs" and the water-closets; but as to the water-closets, they found the people were not "educated up to them." They made a persistent effort in Derby to introduce the water-closets, but they failed because the people would not use them. But I do think that one of the first things we ought to have is, that the School Boards of this country should have taught in their schools some plain elementary lessons upon health and cleanliness. Ever since I have taken an interest in sanitary matters I have noticed that it is what really strikes at the root of the whole thing; and that we should insist upon individual responsibility. Working people, to a large extent, think that they have no responsibility upon them at all; and I do think they ought to be taught in some way their individual responsibility. I do not say that I am prepared to say how much ought to be left to statesmen; but this responsibility should be insisted upon; and if we can educate the growing and younger generation we should do a great deal in reducing the higher rates of mortality prevailing in large towns.

Mr. J. LEMON: Dr. Davies has alluded to the various diseases that are comparatively of modern date. That is true; but he must not forget the very serious diseases which occurred at the earliest times, such as the plague, which has now been swept away, although we have perhaps the cholera in its place. Then he also alluded to the cattle plague and the state of our dairies. Upon that point I think there is room for legislation. The Government are trying to prevent the spread of cattle disease by stopping importations of live cattle into this country. I saw the other day, in my town (Southampton), where the importation of cattle is going on, a cargo of American beasts unloading, and I never saw cattle in such a really splendid condition. They were, in fact, just the same as if they had come out of a Devonshire meadow. There was not the slightest symptom of disease amongst them, and nothing could have been better than their condition appeared. I have come to the conclusion that in a great measure it is a mistake as to the importation of the cattle disease, and that the disease is not

imported into this country by foreign cattle, as supposed ; but that the principal cause of disease arises from the want of sanitary improvements at home. Every one who is in the habit of going into dairies in large towns will testify to the disgraceful state in which the cows are kept, and that it is a matter of surprise if disease did not generate there. The animals are there locked up with no ventilation, and in a dirty state ; they stand up to their hocks in muck. Disease breaks out, and it is an extraordinary fact for reflecting upon, that where disease does break out is in these dairies. There was an instance of this only last week, and I say that to a great extent it does not come from the American or other foreign cattle brought in here. I am very glad that Dr. Davies alluded to this, because it is a question requiring serious attention on the part of all of us. Then, again, he spoke of spreading the area of large cities. If we can do as he suggests, it would be a desirable thing, but I think it is impracticable in the way he proposes. The whole tendency of modern days is to get men close to their work, and to utilize the space as much as possible, and the only way out of the difficulty that I can see is to put them up improved dwellings. I cannot see how we could find space to put them up only one story high. I only wish we could, but the tendency is to put them up in many stories.

Mr. HARPUR (Merthyr) : Dr. Davies has referred to various things, and he has just touched upon one which I should have been glad to have enlarged upon, as one of the most deteriorating evils—the immoderate use of strong drink. There is no doubt that that is one of the greatest evils we have to deal with, after all.

A MEMBER : That is beyond the engineer, I expect.

Dr. DAVIES : The gentleman opposite me asked about heat and disinfectants as applied to germs of disease. I do not know of any way to destroy these germs except by heat and chemicals. We have a disinfecting apparatus, heated by gas, which we have used in cases of small-pox and fever in our hospital. We disinfect all the clothing of the poor for nothing, and those of the upper classes at a moderate payment to the Sanitary Authority ; and I never knew a case arise from the clothing after passing through our apparatus. The destruction of the germs is thus effectual ; and it is absolutely necessary. I do not believe that these fevers generate spontaneously more than a man generates so : every disease of that kind is the offspring of another. When we find a case of typhoid fever, we saturate all the communicating drains for about 200 yards

thoroughly with sulphate of iron and carbolic acid, sending these into every part of those drains. With regard to the question of concentrating the people in a limited area, if concentrating the people is an absolute necessity, which I deny, you must take with that absolute necessity, as its consequence, a high rate of mortality. You may, perhaps, for the sake of economy, say that it is absolutely necessary that a man should live close to his work; but if so, you must then be prepared to have the death-rate which you now have in towns like Glasgow. I know several members of the Sanitary Authority there. The chairman himself is an intimate friend of mine, and I know that he is trying night and day to reduce the mortality of that great city, and he most ably is aided by others; but they find it is absolutely impossible to accomplish this task satisfactorily while the workpeople are housed one above another, tier upon tier. We found in 1865, if we had a case of maculated typhus (which is distinct from typhoid fever) down on the ground-floor of a large house, it would spread right up through the house. It was impossible to stop it. You can shut a case of scarlet fever in a room by hanging over the door a sheet dipped in carbolic acid, but you cannot shut up small-pox; and so with maculated typhus—it will shoot twenty yards off. You may, if you wish it, have your population concentrated, as you say, but, if so, you must be prepared to put up with the result, viz. a high rate of mortality from zymotic diseases, and also a low state of morality. With regard to cattle disease, I say that the rinderpest never was, never can be, and never will be generated in this country. It is invariably an importation from abroad—first from the steppes of Tartary, into Russia, and then across through Germany. It is always imported into England, and never bred here spontaneously. Nobody thinks of talking about an ash or an oak, or a man, or a beast, or anything else of that kind growing up spontaneously. Everything organic is the offspring of another. So is the cattle disease. If they had cleaned their dairies and washed the animals, the cattle plague would have gone through them as though they had not done so. A clean child is as liable to the small-pox as is the dirty child. A clean child in one of the best houses in Clifton, if exposed to scarlet fever, is as liable to take it as the poorest child in the city. It is simply a question of the human being affected being brought into contact with others subject to the disease. With regard to rookeries, they are what the people make them. I could take you into narrow parts of Bristol where people living in four small rooms, in courts,

with dirty people all around them, have remained healthy all through. With Mr. Ashmead's warm support, we have now paved and channelled every court, as we could never have stopped typhoid fever if the children had been allowed to play and relieve themselves on the damp soil. We have not such rookeries as you have in large northern towns, but there are a great many bad, dirty rooms here, simply because they have bad, dirty, drunken people inside of them. If I have to fight small-pox, or cholera, or maculated typhus fever, give me an isolated house in a rookery rather than a large modern lodging-house, with three or four tiers of inhabitants.

[The meeting then adjourned, the President remarking that one or two papers had not yet come to hand. Early in the morning, before they re-assembled, he would have the outlets of the sewers open for the members to examine them, and, as the tide would be low, the working of the syphons could be seen.]

DETAILS OF INFORMATION OBTAINED AND MEMORANDA OF THE SUBSTANCE OF A REPORT PRESENTED TO THE CORPORATION OF READING ON THE SUBJECT OF THE MAINTENANCE OF HIGHWAYS, THE SCAVENGING AND WATERING OF ROADS, AND THE COLLECTION OF HOUSE REFUSE, WITH THE VIEW OF ENTERING INTO CONTRACTS FOR THE WORKS.

By ALBERT W. PARRY, Assoc. Inst. C.E., Borough Surveyor and Waterworks Manager, Reading.

I CONSIDER it necessary to preface this paper with a word or two, lest it should lead to the supposition that it is intended as an attempt to exhaust the subject of the management and cost of maintenance of public highways.

The object I had in view when collecting and collating information on this subject was to show a comparison between the cost of maintaining the roads in Reading with other towns, to lay before a committee of the Town Council, to enable them to consider the propriety of entering into contracts for the whole of the work.

The information that I obtained I consider to be the property of those who were good enough to furnish me with the details I asked for; and by placing this information before the members of the Association in the form in which I now give it, it will have a place among the records of proceedings of the Association for the use of its members.

The whole of the roads in Reading are macadamized or gravelled, and I have compared with Reading such towns only where the roads are similarly formed; but I give also in tabular form the details obtained from towns where the roads are paved and also macadamized.

There are 23 miles of public roads in Reading, of which $17\frac{1}{2}$ miles are made of gravel, the remaining $5\frac{1}{2}$ miles being composed as follows:—

Cranmore Rock	..	..	..	7,945	lineal yards.
Mount Sorrel granite	..	..	..	290	"
Clee Hill Dhu stone	..	..	..	232	"
Flint	..	..	..	1,837	"
Total	..	..	..	<u>10,304</u>	lineal yards.

In other towns as compared with Reading, particulars of which will follow, it will be seen that a greater length of the roads is made of better material, and is to a great extent less costly in maintenance.

The gravel surfaces, on particularly the much-used roads, are seriously affected by wet weather and frost; and during the process of scraping and cleansing a considerable quantity of the road material is necessarily carted away.

Gravel ought only to be used on streets of light traffic, and not on principal thoroughfares, as is much the case in Reading.

STATEMENT SHOWING THE QUANTITIES OF THE DIFFERENT DESCRIPTIONS OF ROAD MATERIAL USED FOR THE MAINTENANCE OF THE HIGHWAYS DURING THE YEAR 1871 TO AND INCLUDING 1876.

	Stone Macadam.			Flints.	Gravel.	Thames Ballast.	Total.
	Cranmore and Westbury.	Mount Sorrel.	Clee Hill Dhu.				
1871	673			596	5976	141	7386
1872	1180			430	1600		3210
1873	1563			138	1060		2761
1874	2233			240	4253	296	7022
1875	2111	105		490	3240	163	6109
1876	3441		281	135	2939		6796

From this statement it will be seen that I have continued to use less gravel and to use more of the better material.

It has been very difficult to obtain a supply of surface picked flints; the price we have been paying has been 4s. 6d. per yard. I am now seeking to obtain a better supply, and have been to a large extent successful by paying a higher price—6s. per yard.

The Cranmore and Westbury stone is not of sufficiently good quality for our much-used main roads.

I should state that during the years 1872 and 1873, and the early part of 1874, the main sewerage works were in progress, which prevented a free use of material to advantage.

To enable the Corporation to make some kind of comparison between the cost of the maintenance of highways in Reading and other towns, I communicated with the Surveyors of forty-five towns, and collated the information thus obtained. I have separated for my purpose those towns having solely macadamized roads.

The details I give as follows:—

	Length of Roads.	DESCRIPTION OF ROAD MATERIAL USED IN OTHER TOWNS.
Coventry	21	Millstone grit entirely.
Croydon	70	Granite 6½ miles, hard picked flints 25 miles, the remainder gravel.
Dudley	30	Rowley rag 9 miles, at 6s. 3d. a ton, 295l. per mile; Furnace slag at 1s. a ton; for breaking material gratis 125l. per mile.
Hanley	33	Leicestershire granite, Cleve Hill Dhu (Basalt) and Rowley Regis stone (similar to Cleve Hill) for 10 miles, the remainder of Furnace slag.
Hastings	24	Guernsey granite where the traffic is heavy; Local flints in large quantities; Beach gravel in outlying districts.
Hereford	30	Clu Hill Dhu stone for all streets and roads, 4000 tons per annum, at 7s. 5d. per ton broken.
Ipswich	70	Local stone (strong flint gravel) 5000 tons per annum, granite 100 tons.
Leamington .. .	25	Millstone grit for all streets and roads; about to try Clu Hill Dhu and Rowley rag.
Luton	20	Granite for central streets, the remainder with picked flints.
Rochester	—	Main streets granite, the remainder with surface picked flints.
Salisbury	6	Main streets flints, other roads gravel.
Shrewsbury .. .	20	Clu Hill Dhu stone, 911 tons; limestone, 1055 tons.
Southampton ..	37	Guernsey granite, 600 tons; 4000 yards of gravel (off Corporation property); should use more granite if we had to buy gravel.
Tunbridge Wells ..	30	Broken igneous rock.
Walsall	56	Broken pebbles, or Boulder and Ponk Hill stone (equal to Rowley rag) for 20 miles, and gravel and furnace slag where traffic is light.
Windsor	11	Granite, 2 miles, the remainder gravel.

It will of course be understood that the cost of the various sections of work will vary according to the average width of roads, the proximity of the town to a stone-producing district, and the quality of road material used, the cost of the carriage being in most cases much more than the cost of the material.

I believe there is no town that can in any way compare with Reading that is worse situated for obtaining good road material at a reasonable cost.

The Cranmore stone costs 9s. per ton. The Westbury stone, 8s. 1d. The Cleve Hill Dhu, a very good stone, and which breaks to a good shape, costs 14s. The Markfield granite and Bardon Hill (Leicestershire) can be obtained at 15s. per ton. Mount Sorrel granite (Leicestershire) costs 17s. Guernsey granite and Purbeck stone would cost 19s., whereas in Dudley the Rowley Rag

costs 6s. 3d. per ton. In Leamington the Ponk Hill (millstone grit) costs 8s. 6d. In Hereford, the Clee Hill Dhu stone costs 7s. 5d.; and so it varies; and the town that can get good stone at a low rate saves much in comparison to Reading in watering and scavenging, as well as the general repairs and maintenance of the roads.

The result of having in Reading such a great length of roads repaired and maintained with gravel, is that we are put to greater expense in watering and scavenging than is the case in other towns.

I know of no town where so much watering is required as in Reading.

To show the cost per mile of repairs and maintenance, and of scavenging and watering the roads in the several towns, I give to each the same superficial area of surface as is contained in an average mile of Reading roads.

I have prepared an analysis of the expenses referred to as follows:—

A mile of carriage ways in Reading contains	15,644 square yards.
A mile of footways	7,822 "
A mile of full width of road averaging 13½ yards ..	23,466 "

STATEMENT SHOWING THE COST IN EACH TOWN FOR AN AREA EQUAL TO
1 MILE IN READING.

	Length in Miles.	Average Width in Yards.	Repairs of Carriage Ways.	Paved Footpaths.	Scavenging.	Watering.	Gross Cost per Mile.
			£	£	£	£	£
Coventry	21	13½					190
Croydon	70	13½	114·27	14·28	24·71	29·32	183
Dudley	30	13½		159·99		3·99	164
Hanley	33	12	23·56	33·66	22·22	4·04	83
Hastings	24	13½					213
Hereford	30	8½					176
Ipswich	70	10		17·14	19·04	13·33	49
Leamington ..	25	15		64·28	45·36	27·05	137
Luton	20	12		81·83		12·12	93
Reading	23	13½	111·51	33·69	35·17	43·30	223
Salisbury	6						258
Shrewsbury ..	20	8½	85·51	4·08	44·95		134
Southampton ..	35	12	61·17	20·24	31·27	10·92	123
Tunbridge Wells	30	9	150·76	8·34	37·03	41·82	238
Walsall	56	12					77
Windsor	11	9½	144·41	30·41	24·02	39·73	239

TEAM LABOUR.

The hire of team labour is a constant necessity, and I have proved that it is cheaper for the authorities to keep good teams than to employ hired ones.

The horses, carts, harness, &c., belonging to the Sanitary Authority have cost, including fodder, men's wages, and general wear and tear, 2*l.* 7*s.* 4*d.* each per week, taking an average of six years, and as compared with hired teams we have had considerably more work from our own teams than from the hired teams, for which we pay 8*s.* per day, or 2*l.* 8*s.* per week.

THE FOLLOWING STATEMENT GIVES THE AVERAGE PER WEEK OF THE TEAM LABOUR EMPLOYED DURING THE LAST FIVE YEARS.

	No. of hired Horses.	No. of Horses belonging to the S. Authority.	Total.
1872	2·31	9	11·31
1873	3·43	9	12·43
1874	6·02	8·50	14·52
1875	3·33	10·16	13·49
1876	3·50	11·08	14·58

THE WATERING OF ROADS.

There are about sixteen miles of roads watered in the dry season.

3½ miles by hand machines, and
12½ miles by horse labour.

The cost of labour per 1000 yards of surface watered twice has been per day :—

For hand machines 3½ pence
For horse and barrels 4½ „

We have ten barrels and water carts and four hand machines, and have just laid hydrants for a district for two new hand-machines, which are now nearly completed; the length of roads in the new district is 2600 yards, with thirty-six hydrants, or eighteen for each machine.

COLLECTION OF HOUSE REFUSE.

I believe the system in practice in Reading to be a good one. The water-closet system having been adopted, there is less need of ashpits, and the removal of the refuse day by day prevents its accumulation on premises where it might otherwise be offensive.

Where ashpits exist on premises where they can be easily

approached with a cart, the contents are removed at intervals when necessary.

The carts when going their rounds take up the boxes of refuse that are brought out, and also take up the sweepings of the gutters

The annual cost per house in the various towns, according to the returns, is as follows, in shillings:—

Croydon	3·73	Luton	0·30
Dudley	3·40	Reading	2·33
Hanley	3·75	Southampton	1·24
Ipswich	2·00	Walsall	2·40
Leamington	3·50	Windsor	(Saved 30% by selling)
Ashton-under-Lyne	9·29	Leicester	4·34
Birkenhead	5·82	Oldham	3·47
Blackburn	4·54	Oxford	4·49
Bolton	5·15	Plymouth	7·14
Bradford	4·85	Preston	3·05
Bury	5·11	Rochdale	8·57
Cardiff	4·01	South Shields	3·20
Huddersfield	3·41	Tynemouth	8·00

SURVEYORS' OPINION ON THE SUBJECT OF CONTRACTING FOR TOWN WORK.

QUESTIONS PUT.

NAME OF TOWN.	Have you any difficulty in obtaining suitable contracts? and do you approve or disapprove of having the work done by contract?
ANSWERS.	
ASHTON-UNDER-LYNE.	We have very little competition and only approve of contracts for new streets; we have not staff sufficient for streets; and again, owners have to pay, and would be dissatisfied if not competed for. Repairs are always better done by day.
BIRKENHEAD ..	Do not approve in the case of public works paid for out of the rates. I approve of works being done by contract, where such works are executed at the cost of frontages, such as the making and levelling of streets, and the paving and drainage of passages. I do not approve of the flagging of the public footways being done by contract. It is found that there is some difficulty in getting the number of horses and carts required, and drivers of a proper description. It is also believed that if the Borough or Local Board provided their own horses and carts, the work would be done at less cost.
BLACKBURN ..	Approve of contracts if properly supervised, my reasons being cheapness and less difficulty in keeping assets, but must be properly looked after.

NAME OF TOWN.	Have you any difficulty in obtaining suitable contracts? and do you approve or disapprove of having the work done by contract?
	ANSWERS.
BOLTON	<p>We formerly let the whole of the private street work by contract, but discontinued that system because of the difficulty in getting the work done properly, both as regards material, workmanship, and cost.</p> <p>We disapprove of letting this work by contract, because we find that we are able to purchase the materials cheaper than the contractors can, and the work is done better and cheaper by our own men.</p>
BOSTON	<p>The scavenging used to be let by contract, but there was so much difficulty in getting the work properly done, that the Board, about eight years ago, took it into their own hands, now employ their own men and horses.</p>
BRADFORD ..	<p>The night-soil contract has only been in operation since July last, but it has been found to work very satisfactorily. More economical than the old system, also the contractor has a direct interest in getting the work done as economically as possible.</p> <p>All daywork for repairs and maintenance of roads.</p>
BRISTOL	<p>Contracts for removal of house refuse, ashes, &c., for term of three years.</p>
BURY, LANCA- SHIRE.	<p>Staff of men, horses, &c., kept for collecting house refuse, &c. Approve of works being done by contract if suitable contractors can be got. If work done by suitable contractors, it is carried out more cheaply.</p>
CARDIFF	<p>Contracts for footpath work, but no other, and have no difficulty in obtaining them. We get the work done very efficiently and with greater dispatch, also much cheaper than the same can be done by the Board. We disapprove of letting all other works, and especially scavenging, as it is never efficiently carried out.</p>
CHESTER	<p>The whole of the works of repairs and maintenance of roads and footpaths are done by men under my superintendence. The ordinary works in this town in my opinion could not be done in a satisfactory manner by the contract system. The workmen employed on the ordinary work I find very useful when I need them for odd jobs, which no contract conditions, however well-framed, could cover, and by this means the total expenditure for town work generally is reduced.</p>
COLCHESTER ..	<p>I find, after some years' experience, that by judicious management the work is better and cheaper done by our own men, horses, &c.</p>
COVENTRY ..	<p>Decidedly not by contract; from long experience I can say the work is better and more cheaply done by the Corporation than by contractors; buy and keep your own horses. Constant disputes arise as to the work done, and in addition to this no person would take it without expecting a profit of 25 per cent.</p>

NAME OF TOWN.	Have you any difficulty in obtaining suitable contracts? and do you approve or disapprove of having the work done by contract?
ANSWERS.	
CROYDON	Not done by contract, with efficient supervision best without contracts.
DUDLEY	There would be a difficulty in obtaining suitable contracts, of obtaining satisfactory materials, and of the materials being put on at the proper time and where required.
GATESHEAD-ON-TYNE.	Perhaps cheaper, but not so efficiently done.
HANLEY	The contract system is a continual dissatisfaction. If any thing is to be done thoroughly well, money must be spent. The contractor hesitates to do this because he must make ends meet. Why should the profit, if any, be paid to him instead of being kept by the ratepayers?
HASTINGS	Do not approve. Work as a rule not satisfactory, especially in a sanitary point of view.
HEREFORD	No. I look at them as systems of robberies; you can never get them to abide by their contracts.
HUDDERSFIELD	No. Consider the work better done by our own men and quite as cheap.
IPSWICH	If we did it by contract there would be great difficulty in obtaining suitable contracts. The reason for disapproving of contracting for these kinds of works is that they are never done so well by contractors as by the Corporation, and this has been clearly shown in all towns where it has been adopted; it requires so much supervision. My experience is that the things are never done so well as when done by one's own staff, over whom you have full control.
LEICESTER	Do not approve of contracts for maintenance of highways; because the work under contract was never satisfactorily carried out.
LINCOLN	All the works are done by the Corporation with the exception of contract for emptying privies, ashpits, and cesspools for part of district. The reasons for disapproving is that the work does not get well done, and consequently great complaints are made.
MAIDSTONE, KENT	No works by contract.
NORTHAMPTON ..	No works by contract. The reasons for disapproving being on account of the extra expense and the inefficiency of the service; a contractor's object being to do as little as he can.
OLDHAM	Contract for removal of nightsoil to the Carbon Fertilizer Co., Limited, at 3s. per house per annum, mills and workshops included, though not counted for a term of twenty-five years. No contracts for highway works.

NAME OF TOWN.	Have you any difficulty in obtaining suitable contracts? and do you approve or disapprove of having the work done by contract?
	ANSWERS.
OXFORD	Twice in the last ten years we have tried contracting for scavenging streets, &c., but were forced to give it up after trials of three years and then six months. The work was not done to time or satisfaction, and we found we could do it cheaper ourselves.
PETERBOROUGH .	No contracts.
PLYMOUTH ..	Contracts for cartage of stone, soil, and watering contract for removing soil, &c., five years; other contracts, two years. I approve of the cartage work being done by contract. Scavenging is best performed by day labour. Roads are better made by day labour.
PORTSMOUTH ..	A contract is taken for three years for supplying horses, carts, and drivers, which is very unsatisfactorily performed. I do not approve of repaving streets and footpaths by contract, as I have found by long experience that contractors will scamp the work, if possible, in order to make it pay, and that it is utterly impossible to completely control them. I perform all public works by our own men, whose only object is to do it well and at prime cost, without the intervention of a contractor's profit.
PRESTON	Contracts for twelve months for collecting house refuse, ashes, &c., removing street sweepings. Contract for removing nightsoil, 2950 <i>l.</i> ; removing street sweepings, 550 <i>l.</i> ; total, 3500 <i>l.</i> There are two or three suitable contractors. Do not approve of having works done by contract, as the difficulty of getting the contractor and his men to perform their duty in a satisfactory manner and to cart all the refuse and dry ashes, &c., out of the borough according to contract, the men frequently tip the ashes, &c., in the brickfields, &c., in the borough if they find the night inspectors are out of the way.
ROCHDALE ..	No works by contract; the reason for disapproving being because in repairs the men are so scattered and many of the jobs so small that a private individual would generally see as little of them and have as little control of his men as a surveyor has; and further, I declare no person would undertake it without having a very large margin in the amount of his contract to meet changes of opinion as to when roads are or are not in good repair, which margin he would generally pocket as a bonus over a fair trade profit.
ROCHESTER ..	That the materials may be supplied and delivered by contract, but that the work be carried out by weekly labour under the surveyor's directions.

NAME OF TOWN.	Have you any difficulty in obtaining suitable contracts? and do you approve or disapprove of having the work done by contract?
	ANSWERS.
SOUTHAMPTON ..	We had and we have given up the contract system, because it was inefficient. My experience of about twenty years teaches me that the contract system leads to all kinds of discontent, difficulties, and complaints. When we were under that system there was hardly a meeting of the Board without complaints of the contractor; now we do the work ourselves, we never hear of any. In fact, the only department which is badly done is that by contract, viz. the removal of ashes.
SOUTH SHIELDS	Contracts for one to three years for paving and flagging. Some time ago we tried the horse hire system for scavenging, emptying ash-pits, maintaining roads, &c., and it worked very unsatisfactory; upon my strong recommendation the Corporation purchased horses of their own, since which the work has been done most efficiently and without any trouble, and I should certainly never recommend the contract system for carrying on the work of a town.
TUNBRIDGE WELLS.	Do not approve of works by contract, reasons for disapproving being inefficiency and greater cost than by employing our own men and carts.
TYNEMOUTH ..	A running contract for paving of streets only being terminable at three months' notice by me or six months by the contractor, and also have great difficulty in obtaining contracts.
WALSALL	No doubt a good deal would be let by contract if suitable contracts were obtainable. I do not think such work as scavenging and repaving streets would be so efficiently done by contract.
WARRINGTON ..	No works by contracts.
WINDSOR	Approve of works by schedule of prices, the work being done cheaper, and have no difficulty in obtaining tenders.
YORK	Do not let works by contract.

My opinion on the subject of contracting for the maintenance of highways is, that if contracts were advertised for now, the contractors would base their tenders upon the cost of maintenance during the last few years, being the time during which the roads were made up, after the execution of the main sewerage works and the continuing house drainage works, and consequently when the roads have cost the most money, they would then put a profit upon it; they will also know that the streets and roads will be greatly disturbed by the house drainage works, and that for some time the main sewer trenches will sink.

All this will be estimated in various ways, and if a low tender is

accepted, the chief aim of the contractor will be to make the work pay him, and the cost of supervision will, in consequence, be greatly increased.

Contractors will not lose money if they can help it, and if there is any profit to be obtained, I submit that it ought to belong to the ratepayers.

In many towns the system of contracting is approved for works of private improvements, where owners of property have to pay the cost; the owners of property are often, I have no doubt, better satisfied when the work is put to competition, and the lowest tender accepted; but my experience of such works is, that town authorities can obtain both labour and materials cheaper than contractors, and with efficient supervision, the work costs less money.

DISCUSSION.

Mr. HARPUR (Merthyr): Mr. Parry has referred to a hand-watering machine, and I should like him to explain it a little further. Then as to the steam road-roller, that seems to be the chief question in point. During the last eighteen months I have employed on my roads one of Aveling's 15-ton steam-rollers, and I find it to be very advantageous in many respects. One benefit resulting from it is the fact that we have been able to do our scavenging for about 400*l.* less during the present year in consequence of the roads having been rolled—a saving of from 350*l.* to 400*l.* a year at least. There are also numerous advantages in making macadamized roads of limestone, and especially by the use of steam road-rollers. The economy is immense, there can be no question about it; the economy of wear and tear in the use of roads by vehicles is considerable, though it is difficult to arrive at any definite conclusion as to the extent in that respect. Another great advantage is, that you may make the roads at any season of the year—in fact, you may make them better in the middle of the summer, when the roads are hard, than in the winter. Then you have your streets constantly free from loose or broken stones, and the whole place is exceedingly improved in appearance in consequence. The roads are not only in better shape but they maintain themselves in better shape, and I believe that with the same amount of material the macadamized roads under this process will last longer than by the ordinary process, when you are obliged to grind the edges in and spoil your material before it really becomes set. I believe, on the whole, it will be found that with the steam-roller we are able to make and maintain our roads in a far superior manner, with a considerable saving in scavenging and other matters—probably 33 per cent. less than formerly.

Mr. BOULNOIS (Exeter): I should like to ask Mr. Parry's opinion as to the value of surface-picked stones as compared with other material—whether he considers them as good, or better, or inferior. Also his opinion as to machine-broken stones—whether they are as good broken by Blake's machine or any other machine—whether they are as good as hand-broken stones. On the question of steam road-rollers I must say that I am not in favour of them

myself, for several reasons. One of these is that the excessive weight of the machine crushes the stones into the road without allowing them to properly dovetail in with the other stones, in accordance with Macadam's theory. Then it is necessary with all steam-rollers to use a "binding" material, which must be deleterious to the road; it eventually washes out and the road goes to pieces. I may instance the roads in the neighbourhood of London, in the suburbs, where they used to be much harder and better than they are now, and I attribute this entirely to the excessive weight of the steam road-roller. It is true the machine makes them in about twenty-four hours, but they go to pieces in a much quicker time than formerly.

Mr. LEMON: I think I may say that those defects which Mr. Boulnois refers to in London arises from the desire to go "too fast." Now they have got the steam-roller they think they ought to make the roads in an unreasonably short time, and open them for traffic immediately. That necessitates a binding material; but I don't say that a binding material with road rollers is a *sine qua non*. If at the outset a good level bed was formed you would find that there were no injurious effects from it. I go in strongly for road-rolling machines, although I cannot get my Board to buy one. I think, however, that the advocates of road-rolling have made a mistake in going in for too heavy a roller. In Liverpool they have a roller of 30 tons. I think that out of all reason. (Mr. HARPUR: No, it is 25 tons.) Well, I know they had one of 30 tons, if they have not now. Mr. Harpur says he uses a 15-ton machine. But I think 10 tons a good weight. I should like to hear something of Mr. Harpur's experience as to the weight of the roller; whether he thinks 15 tons too much, and whether he would prefer one of 10 tons. With regard to the statistics given by Mr. Parry, they are very valuable indeed. I only hope the members of this Association who are in the habit of collecting statistics for similar purposes will make a practice of sending them to the Secretary of the Association, so that we might all have them bound up in our proceedings. Since I have sent in the returns for my borough, we have had another contract, and the cost has increased this time. I used to advocate the doing of the whole of the work ourselves, but my Board has accepted another contract at a considerable increase in price. The reason why the cost in my borough is very low is that we get exceptional advantages. We have a gravel bed belonging to the Corporation, and we can get as

much as we like simply at the cost of digging; that makes a difference. The cost of digging and horse hire is also low indeed. We used to get a horse and man for 6s. 8d. a day, and now we shall have to pay about 7s. 8d. or 8s. 2d. It is, of course, a great drawback that there should be this springing up of the prices, but I quite agree that the proper course is that every Local Board should find their own horses. I have been collecting information from different towns where they supply their own horses, and I find, most conclusively, that the cost to any Board would be less, and the work would be done better, than it would under contract, and I regret exceedingly that they have adopted a different course. Then, as regards taking contracts for improvements, we have had a striking illustration of that lately. I issued specifications, and received tenders for making new streets and private improvements, and the lowest tender was 200% above my estimate. The committee said to me, "Will you do the work for the money?" I said "Yes, and have a balance in hand." They replied, "Then you had better do it," and I have done it, and I think I shall be saving nearly 200%. And yet there was no contractor near my borough who would attempt to say he could make the roads at the same price I could—much less do it. In fact, if there is a little road to make, owners of property and small contractors have come to me and asked to borrow some of my men. It naturally follows that men who are doing the same thing year after year get more perfect at their work than men employed by contractors to only do a job now and then. I am quite sure that the works of private improvements of this kind can be done cheaper by the local authorities than they can be done by contract.

Mr. LOBLEY (Hanley): I cannot see why the granite should be so expensive at Reading. My idea is that it cannot be so much farther from Bardon Hill than my town is. The price we pay is 10s. 6d. per ton for broken Bardon Hill stone. I think that the railway gets out of that 6s. or 6s. 6d., and the quarry gets the rest. The question, what rollers should be used, is certainly a very interesting one, and I should like to know whether any definite conclusion has been arrived at by anyone as regards the gradient. There must be a limit somewhere as to the gradient upon which a steam roller can be used. I have a water-ballast roller, but I cannot use that on a steep road at all. It would take four or five horses to use it. With a steam-roller the control would perhaps be practicable; but there must be a limit somewhere. As I have a great many roads

of 1 in 15, I should imagine they would not be suitable for steam-rollers at any rate. With regard to the crushing, my experience of the heavy steam-roller at Liverpool—the 30-ton roller—when I was there I noticed it constantly, and with good hard granite I did not find that it crushed the stone much. It certainly does bind them together better than if left to the ordinary traffic. With limestone it might act differently, and crush it too much. In my neighbourhood we should find great difficulty in the matter, because of the gas-pipes and water-pipes—they would all have to be taken up and relaid. As to the contracts for private improvements, I do a great deal of work with my own men for private improvements, and what we cannot do with our own men we let out by contract. I always find it much cheaper to have it done by my own men. But, in spite of that, people think that by going to the open market they get it done at a cheaper rate and better looked after than when under the Corporation workmen. But, as I have said, the result has proved that the work is done cheaper that when the work is so taken by contract. I make a distinction with regard to the contracts for private improvements: if they have been partly done by the owner, we do them—finish them ourselves; but if nothing has been done, then we have it done by contract. I hope with Mr. Lemon, that every member sending round questions and requisitions for statistics now and then, when they collect the answers to their questions and obtain any statistics, will send them to the Secretary of the Association.

Mr. ELLICE-CLARK: Mr. Parry's paper has been so general, and has touched upon so many subjects, that unless it were printed and placed in our hands before the meeting commenced, it would be impossible to criticise or to go through the whole range of the subjects it treats of. I should, however, like to bear testimony, having some work going on now, with regard to what Mr. Lemon and Mr. Lobley say as to carrying out works ourselves. My experience has not been a long one, but Mr. Harpur has been a contractor, and I should prefer his experience to that of a younger member. It is not a matter you can decide upon off-hand; and as there are many towns which may have peculiar local circumstances, I do not think that this gathering can assist us very much. I am now carrying out the reconstruction of a system of sewers for the west-end of Brighton. The whole of the streets were built upon, and the whole of the houses had water-closets; but there was no system of drainage, and it was rather a difficult undertaking. We have to

deal there with sewage and rainfall in the same channels as we put in the new sewers. We advertised for contracts; and, having taken out the quantities in the usual way very fully, I took a great deal of trouble in preparing the drawings, showing each of the old sewers, their depths, and the various wells, &c., so that we might get a very close estimate indeed. When we opened the tenders we found they ranged from 7400*l.* to 14,000*l.* The gentleman who sent his tender for 7400*l.* was a well-known London contractor, who qualified his tender with the statement that, as the work of reconstruction was almost unique, with the connection of the houses with the sewers, &c., he had put down a "large margin." So that the gentleman who had put his tender at 14,000*l.* must have put on an extraordinary margin indeed. Well, this lower sum was something like 750*l.* or 1000*l.* above my estimate, and the Commissioners asked me if I would undertake to do it myself instead of having any contract. I wanted to win my spurs there, and I consented, although I saw that it entailed a vast amount of labour and responsibility upon any surveyor having his ordinary duties to perform, especially in a large growing district. Unless you have a good staff, and a thorough system of book-keeping—in fact, unless you become a contractor and make a thorough business of it as a contractor—the works may cost you more. But I believe engineers are possessed of as much brains as contractors, and that boards have as great facilities for obtaining materials, and they can borrow money at a low rate. I believe, also, that they can get labour and materials as cheap, though, perhaps, not cheaper than contractors. Well, we have now finished one-sixth of our works, and we have completed them for something like 15 per cent. lower than my estimate, although under all the streets we have had water and difficulties to meet with that we did not expect. We have, too, in one length of sewer, where the average depth was 16 feet, the whole of the ground made ground. Still, the doing of the work ourselves has saved and is saving us a considerable sum of money. It would be premature to say whether upon the whole job we shall save money, but that has been our experience; and I believe if surveyors will take the trouble to organise their staff to assist in well looking after the book-keeping, and go into the market as buyers, they will save a great deal of money. With regard to the question of keeping our own horses, I think anyone who has had experience will find it cheaper, and more effective as regards the work, because you then have entire control over the men. In a

town like Brighton, the work of watering the roads is really extraordinary, because it lies upon chalk, whereas your roads in other places lie upon gravel or flint. In Brighton, within two hours after a rainfall of twenty-four hours, the roads want watering, and it would be difficult, if not impossible, to arrange with a contractor, and pay him, so as to secure his constant attention in this way. At any rate you could not do it except for a large amount of money in excess of the ordinary rate of payment—the rainfall is so fickle, and the attention required would be so close and constant. I believe that the Corporations save a considerable amount of money in cases where they adopt the plan of keeping their own horses. In Derby, where they remove all the nightsoil in carts, they have found it a considerable saving in keeping their own horses in that department, and now they are going to keep their own horses for every purpose required. The Camberwell vestry of London—a large and populous district of the metropolis—have recently applied to the Board of Works Commissioners to borrow money for the purpose of buying their own horses, and I find that it has been granted. I can say this for Camberwell, that a more business-like man, or a more experienced man, than their surveyor cannot be found in any other similar position in the country; and he has had large experience in these matters. With regard to watering by hand-machine, a committee of my Commissioners went to Reading, and saw Mr. Parry's system of watering by hand. They also went to other towns, including Tunbridge Wells, and purchased some of those machines, and we have now two in use. There are some advantages, and some disadvantages, connected with them. In streets where we have from 2000 to 3000 vehicles passing a day, we could not use these machines; the hose would be cut to pieces very soon by the traffic. But I believe that in streets of steep gradient, like in Newcastle, and some streets you have here in Bristol, where there might be comparatively little traffic, the hand-watering machines are more economical and quite as efficient as watering by carts. I have lately made experiments with a low watering-cart on Bailey's plan, and I find that it does something like 20 per cent. more work than either of the machines at the same price or the ordinary carts. With regard to the question of the road-rollers, there has lately been an accident in Brighton. They had there a 15-ton roller, and they have broken a large gas main, and nearly blown down two houses. The gas main was only 1 foot 9 inches from the surface, and they did not find out that

there was an escape from it for some time ; and it got into a cellar, and destroyed about 3000*l.* worth of property. I would therefore advise the members to be very cautious how they use these steam rollers. I am just now repairing a wide road of 66 feet roadway, with hand-picked flints. It is a road about which there has been some dispute, and for about six or seven years there have been no repairs upon it at all. We re-formed it, and then put a coating of flints upon it. I could not have repaired this road in winter. It wanted thoroughly re-forming and "clothing." The right thing is that a road should "have a pair of breeches upon it," as Macadam expressed it. You should "clothe" it. The bottom should be made to take the weight, and the top the wear. We cover the road with flints, and it is constantly rolled when there is a wet day. I want the road to last. We put no binding materials upon it at all. I believe with flints you do not want any binding. Only get a good hard bottom—I do not believe in having a soft bottom to your roads. I believe, as I said, in having them well clothed, and if you do that I do not believe you want any binding at all. The consequence is, the whole of the metal of the road gets well knit together and cannot move ; when finished, the work upon it is very trifling, and I believe it wants less watering and scavenging than if you had put upon it a binding material. Mr. Parry has referred further to the removal of the ashes in Reading. I would ask whether they are removed every day ? Are there many towns in England where they remove the ashes, like they do in Scotland, every morning ? I certainly believe that in a large town the system might be adopted, and found more economical than in removing the ashes every week only. Any statistics about this removal of ashes would be very valuable.

Mr. G. COLE (Hereford) : One gentleman has asked a question about stone-breaking machines. We have just got one at Hereford, and I believe it answers remarkably well. It turns out the stones very well indeed. At the first the quality was not so good as we have now got, but we are now able to take out the fine stone, which we use for gravel walks and so on, and we find it answers the purpose very well. We formerly were obliged to give 2*s.* 3*d.* per ton for breaking stone, and in some cases 2*s.* 6*d.* per ton ; but now we can get it broken very well for 1*s.* per ton. I have a very firm opinion that stone-breaking machines will answer their purpose remarkably well. As to the rolling and binding of the metal in the streets, we have got a 5-ton roller, and we generally use the "drift"

we get from the street-sweeping machine, which affords very good material for binding, and we use it over the surface of the newly-made streets, which we get quite solid immediately; in fact, in the course of a day we can make so good a surface to the street that you would hardly know it had been newly made. Some of our streets are remarkably narrow, where it would be awkward to have the traffic long delayed; therefore it is a great advantage to get them solid as soon as possible. We use this "drift," and we find it answers remarkably well. We find the large size stones do not make so good a surface as the smaller ones; and we generally select out the smaller stones for the narrow streets, as they offer a better surface in a limited time.

Mr. HARPUR (Merthyr): In our system of rolling we break up the surface first, and level the whole as nearly as possible, and then put a uniform coating of stone over it; we then send the roller over the stone while it is perfectly dry, and bring out a perfectly even surface before we put what is called in our neighbourhood the "hogging" upon it, and a dressing of small stone. We bring out a uniform surface. In the first instance, we put on perhaps one load of gravel—good gravel, of the same material as the broken metal, and one cart-load is about sufficient for 30 or 40 square yards of surface; we found the result very satisfactory. The stone we are using is a very tenacious, or tough, limestone, something like your black-rock stone, in this neighbourhood, indeed very similar to it. The stone is not crushed, and there is no getting under friction. The road itself forms something like a pitched road. After the road is completed, there is very little of the surface gravel to be seen, and you may go over the road and mark the joints of the stone distinctly. In the best material there is no crushing of the stone; it is forced into its place and answers very nicely. The weight of the machine is 15 tons. The width of the machine, including the two front rollers and the two hind rollers, is 7 feet 6 inches; so that there is one ton for every 6 inches. It is not unusual for a cart-load of coal, a very heavy material, to get two tons upon that space, thus putting, with 3-inch wheels, just double the crushing power upon that space that a roller puts. As I have said, the machine we are using is a 15-ton, and we have in our town some roads of very considerable gradient. We have during the past fortnight been making a piece of road with a gradient of 1 in $9\frac{1}{2}$, and the machine has done its work remarkably well. Everybody was satisfied, and the remark

was made while the machine was doing its work : " Well, if you had put these stones on the road without being thus rolled in, one-half would have got to the bottom of the hill before they could have got set, and the other half would have been spoilt." In consequence of the steep gradients of our roads, we have had a special break made for our engine. It was supplied in the first instance just as it is at other places ; but I considered it was hardly safe for these steep hills. There was a tendency to " run," despite the break supplied originally with the machine, and which, as I have said, was evidently not sufficiently powerful for those gradients ; we therefore had the special break made, and with two large blocks of timber for the driving wheel ; and we could stop the machine instantaneously on a gradient of about 1 in 9 or 10 without any difficulty.

THE PRESIDENT : Do you prefer the contract system ? One of the members asked that question, I think.

MR. HARPUR : Mr. Clark, I think, said I had been in business as a contractor, I was a surveyor ten years before I was a contractor ; and I have now been a surveyor for fifteen years since I was a contractor ; and I have no hesitation in saying that if a surveyor has had some experience in these matters, and will lay himself out for the work, he can do it for his Board cheaper than a contractor would do it.

MR. ALLEN (Stratford-on-Avon) : I attended the district meeting at Kidderminster a short time ago, and the day we were there they had been coating a road, and were using a steam-roller upon it. I was much impressed with the quantity of small material they put upon the surface of the streets. It seemed, indeed, to me a perfect mire as the machine passed over it. It greatly impressed me with the conviction that a mistake was made as to the quantity put on. My experience has been that whatever you put on in the shape of small material on the roads of a town you have to scrape off in the shape of mud or dirt. My plan, therefore, is to put as little as possible upon the surface in this way, to save scraping it off afterwards ; because, as a rule, that has got to be done. The road should, in reality, present the appearance of the surface of a pitched road, and then you have a perfect road. I think we are all deeply indebted to Mr. Parry for the valuable paper he has read to us. We are not only connected with the construction of sewers, but we are all interested in maintaining the surface of the roads, because we all know, as surveyors, that if we keep the roads and streets in

good condition it has a decided effect upon the watering and upon the daily labour expended upon it. If you get a good surface to your roads you do not want to expend so much in daily watering and cleansing. I very much thank Mr. Parry, therefore, for bringing forward and laying before us the particulars he has produced. I may say that I have some information and statements brother surveyors have kindly favoured me with, and I shall be happy to furnish them for the edification of my fellow-members of this Association. I have often thought if statements of that kind were published with our Transactions, they would give us a good deal of valuable information for our guidance and for reference; and then I think the charge made yesterday about the meagreness of our Transactions would be reversed, and we should swell our Transactions so as to have a good deal of valuable information in a small space. With regard to the laying of gas mains, I think gas companies frequently make a mistake. In my town the gas company lay the mains at such a little distance below the surface of the streets, that it is no wonder they are injured. They are not laid deep enough. They are, indeed, at such a slight distance below the surface that really a frost affects them frequently. I know a town where the water pipes are laid at so little a distance below the surface of the streets that the first winter the frost broke many of the pipes and obstructed the water supply of the town. Therefore, if gas and water pipes were laid at a low level, it would be more desirable in every respect, and they would not get interfered with. With regard to the removal of ashes, we have just issued a circular telling the people to provide themselves with portable pails, and we have adopted a system of going round once a week to collect the ashes.

Mr. HARPUR: We collect the ashes every morning.

Mr. ELLICE-CLARK: That is the system, sir.

Mr. ALLEN: I think for small provincial towns that might not be necessary. But we have done this to get rid of the abominable nuisance of ashpits. With regard to the Mount Sorrel granite (Leicestershire), the railway charge to my town is 7s. 6d. per ton; but I am using a hard stone that costs us 9s. 2d. per ton.

Mr. PARRY: With respect to Mr. Harpur's question, I will leave that to the last. As to the working of steam-rollers, my view quite accords with that of almost every gentleman who has spoken this morning. I am decidedly in favour of them. I have asked my Corporation to let me have one; but several of the members feel

that a great deal of money has been spent upon the roads in Reading, and a few hundred pounds frighten them. They all acknowledge with me that it is one of the best things we could have, and I dare say we shall have it some time. With regard to the character of the material you should put on the surface, I am of opinion that picked flints are worth many times more than the others you get out of the chalk. We have had a great quantity of the latter out of the excavations from the sewerage works, but I have never put it on the roads; it is too brittle. But the surface-picked flints which are picked up from the surface, seven or eight miles from the town, are carted in and we have only to pay 6s. for it; but it used to be delivered—plenty of it—at 4s. and 4s. 6d. We make our roads in the way described just now, without binding. With respect to the breaking of the stone, I dare say it would be a difficult thing to have it broken by hand, except by paying pretty well for it. Breaking by machine is almost a necessity now, on account of the quantity of stone used; but breaking by hand is far superior to breaking by machinery. The stone broken by machine is, to a great extent, laminated, and instead of knitting the whole mass together, they seem to lie on top of one another. Machine-broken stone certainly does not make so good a road as hand-broken stone. I have the opportunity of having the hand-broken stone done at the gaol. They let me know when they want stone for the prisoners to break, and I take care to let them have some good hard stone that I want broken by hand. With respect to the Bardon Hill and Leicestershire stone, it cost us 11s. to have it delivered into Reading; but I cannot get the Mount Sorrel stone under 17s., though that comes only four or five miles from Bardon Hill. It is all in one district—Mount Sorrel, Marksfield, and Bardon Hill, with only about a mile or half a mile between them. There is communication between Marksfield and Bardon Hill. The 11s. is the carriage alone into Reading; but I dare say there is some difficulty about the railway arrangements. Some of my roads I am obliged to make without waiting till the autumn. I mix the Macadam stone with tar (cold tar); and I have made a good road, with a good wide surface, entirely by steeping it a little in cold tar, and rolling it lightly. With respect to the removal of house ashes and refuse, I move it every day in thickly populated districts, where it accumulates very fast, and in other cases two or three times a week, as it is necessary to entirely govern oneself in these matters by circumstances. Mr.

Lobley mentioned the doings of some of the work in private streets with his own men, after the work had once been started by the owners of the property. This is the first time that I have heard that the owners of property did start the work.

Mr. LOBLEY: I do not mean owners of property under notices served upon them; but that we find some streets in existence not yet adopted by the town, but in which some of the work has been done. We have about eighty streets that have been made in this way. At any rate, sixty of them had been sewered, kerbed, and metalled, but none of them had been fully completed.

Mr. PARRY: With respect to watering machines, I thought I had here a draft of the specifications, but I find I have not. [Machine described by means of illustration on the table.] If it be of any interest to any member, I shall be pleased to get a lot of photographs, and send them to any gentleman who wishes to know anything further about the machine.

The PRESIDENT: In these hand-machines do you use the water by meter?

Mr. PARRY: I have had the pipe in the centre carriage cut off in the middle, so that I could put a meter in whenever I want to measure it; but we have plenty of water, and do not pay specially for it, the water-works being our own. We find that by these hand-machines we can throw more water on to the roads, and it is cheaper to have them than to have a horse and cart. We use them on the wide roads, but in the narrow roads they are certainly in the way, especially where there is plenty of traffic. The narrow roads you ought not to find need of the water so often; it is the wide road that needs the most water.

APPLIANCES FOR VENTILATING HOUSES AND EXCLUDING SEWER GAS.

MR. MASTERS (architect, Bristol) submitted for inspection his plans for ventilating houses and excluding sewer gas from them, explaining both by a series of diagrams.

MR. ELLICE-CLARK: It appears to me that these principles laid down with respect to sewer gas are not founded upon actual experiment. Mr. Masters says the pressure of sewer gas forces the water in the trap. I do not believe that there is much, if any, pressure in sewer gas. The gas passes into the water and escapes by levitation and not by pressure. The capacity of water for holding sewer gas is very analogous to that of sponge for holding water. A cubic foot of sponge will hold so much water, and as soon as it becomes charged the water drops by gravitation. A cubic foot of water holds so much gas, and as soon as it becomes charged the gas escapes by levitation. The specific gravity of sewer gas is much like that of air. The result of a large number of experiments made by Dr. Russell and Mr. Nicholson, and one or two I have made myself, showed that, taking the atmospheric air at 1000, sewer gas has been represented by 1096. The diffusive power of the gas is very great. I want to know whether this term, "pressure," so constantly used by surveyors and gentlemen who take an interest in it, is a matter of absolute certainty and reality. Mr. Nicholson, in Sunderland, had a pressure gauge made, and his experiments were extended over something like two years; and he found that the greatest pressure he could get was .5 to the oz. upon a square inch. I do not think that that would anything like force a water trap; and, as I said, I believe the idea of the trap being forced by the pressure of sewer gas is erroneous. The gas that passes in escapes by levitation.

MR. HARPUR: I cannot understand how it is possible to pour any water in the duct marked A, to form a complete plug down the pipe; the water would run down and the circulation in the pipe be a great deal faster than it would pass through a syphon

trap, and would not form anything like a plug, or force anything.

Mr. LEMON: What are called "traps" form one of the popular errors. I believe they are not traps at all: they are simply syphons if there is ventilation to them. And I quite agree with Mr. Clark that the gas does escape as he says, and not by pressure.

Mr. MASTERS: So far as the first question relative to the term "pressure" of gas, perhaps it is an erroneous word that we use, not practically understanding the question of gas so much as others; but still, I know as a fact that something comes through the syphons, and to a large extent in my own case that I mentioned. I had one of these traps, and now and then I got the noise of something passing through, and the stench then was abominable. I did not use the word "pressure" perhaps in the way it should be used. But the water, in passing down the pipe, did form a kind of "plug," as stated, with the result I have described. Just as in the circulation of a rain-water pipe, the water in passing down will force something before it, and therefore these are not recommended as a rule for ventilating pipes.

Mr. LOBLEY having exhibited to the meeting and described Amsler's planimeter, a vote of thanks was given to the President, and the meeting terminated.

THE BANQUET.

THE banquet took place in the evening, at the Clifton Down Hotel, under the presidency of Mr. F. Ashmead, who was supported by the Right Worshipful the Mayor of Bristol, Mr. George W. Edwards; Mr. C. H. Low (Chairman of the Sanitary Authority Committee of the Bristol Town Council), Mr. W. M. Webb (Bristol Town Council), Mr. Wm. Brice (Town Clerk of Bristol), Mr. T. Howard, C.E. (Engineer to the Bristol Dock Committee), Mr. W. Lemon (ex-President of the Association), Mr. Chas. Jones (Hon. Secretary), Dr. Davies (Medical Officer of Health for Bristol), &c. The vice-chairs were occupied by Mr. Ellice-Clark (Hove), and Mr. Harpur (Merthyr), and there was a large attendance. The following were the speeches after the repast:—

The PRESIDENT: Gentlemen—In an assembly like this we are always ready, as Englishmen, to receive the toast which is first on the list, and I am sure on the present occasion no recommendation is required from me in asking you to drink to the health of Her Majesty the Queen.

The PRESIDENT: The second toast on your list also needs no words from me, as I am sure you will all readily unite in drinking the health of the Prince and Princess of Wales and the rest of the Royal Family.

The PRESIDENT: You will excuse my hurrying the toasts a little, as some of those present have a long distance to go and cannot very well stay late. The next toast is "The Municipal Institutions of the Country." I am sure you will receive that toast with enthusiasm, as this Association has now become one of the municipal institutions of the country, and it will, I trust, continue to make its influence felt throughout the length and breadth of the land. We have with us to night our worthy chief magistrate, who has put himself to some considerable inconvenience to be present. I may here say I hold that local self-government is well suited to our country and to us as Englishmen; and we have in the Town Council men whose only desire is to promote the well-being of

their fellow-citizens. Representing those members in the Council also, we have here to-night the Chairman of the Sanitary Authority Committee, Mr. Low, and the Vice-chairman of that Authority would have been present had he not been prevented by a domestic affliction. We have also with us Mr. Councillor Webb. In giving you the toast of "The Municipal Institutions of the Country," I am going to couple with it the name of Mr. Alderman Edwards, the Mayor of Bristol, wishing him long life, health, and prosperity.

THE MAYOR OF BRISTOL (ALDERMAN EDWARDS): I have to thank you most sincerely for the kind way in which you have associated my name with the toast of the Municipal Institutions of the Country. I have no difficulty in acknowledging that toast, for, as your President has said, the advantages to our native land of its municipal institutions are patent to everyone. This is more especially so when we contrast those institutions with what has taken place in other countries. When we reflect upon the municipal institutions which several centuries ago were established in Italy, Spain, Germany, and which were of such immense advantage to those countries, and which now, alas! I may say are in some measure in the shade—when we contrast them with the municipal institutions of our own land, we find ours still growing up as they have ever done, and privileges originally secured for towns surrounding some fortress or stronghold have gradually grown and increased, to the advantage of the surrounding population; they have never suffered any eclipse in this happy country, but those institutions are now as efficient and useful in our own day, and even more so, than they have ever been. I have, therefore, much pleasure in responding to the toast, and congratulating ourselves and the country generally on the advantages which municipal institutions afford. Before I sit down I wish to give you a toast which, but for its being handed to my care, I should call the "toast of the evening," and which, I venture to suggest, might have come perhaps from your worthy President. But, as he has forced it upon me, I have now the pleasure in giving you "The Association of Municipal and Sanitary Engineers and Surveyors." Of course, it is impossible for corporations to carry out the advantages which they foresee and the benefits which they contemplate for the welfare of their fellow-citizens unless they are ably supported; and the way in which we are supported in this city by our municipal officers is patent to all those who now hear me, as

it is to my fellow-citizens generally. When we see here to-night the gentleman sitting near me, your excellent President (Mr. Ashmead) and Dr. Davies, surely the advantages the city has derived from their labours must be present to the minds of all of us. Then there are also here Mr. Josiah Thomas and other officers whom I need not name to you. We who know them here are certainly fully aware of the benefits we derive from their labours. And I am quite sure that those members from distant cities in various parts of England who have done us the pleasure of visiting our ancient city must equally feel the benefit which a large city like this reaps from the possession of such officers; while, doubtless, in their own localities their services also are frankly acknowledged. I have been very glad to meet you to-day, and I trust you will have fine weather for the next two days for your excursions around the neighbourhood. I have now much pleasure in proposing "The Association of Municipal and Sanitary Engineers and Surveyors," coupled with the health of your President, Mr. Ashmead.

The PRESIDENT: Mr. Mayor and Gentlemen—I thank you sincerely for the kind manner in which this toast has been proposed and received. Our Association must still be considered to be young, this being only its fourth annual meeting; but I think it has already done some service, and it cannot fail to do more if its members will only make an effort to attend the various meetings, where, by the interchange of thoughts and ideas, backed by the practical experience of each, all will be sure to profit. I have now been in my present municipal office upwards of a quarter of a century; and I can truly say that I have always received the support of the majority of the Council, and that I have endeavoured to carry out the duties of my office to the best of my ability, and without fear or favour. And if our friends will bear this in mind, that the performance of their various duties is only to be satisfactorily accomplished in this way, they will be sure to obtain the respect and esteem of the majority of the members of their respective municipal authorities. I again thank the Mayor for the very kind manner in which he proposed this toast, and for his presence here this evening.

Mr. LEMON: I have been asked to propose the next toast, and I do it with a great deal of pleasure. It is that of "The Municipal Officers." I think it is a toast which very properly follows that of the municipal institutions of the country, because those institutions could not be very efficiently carried out without experienced muni-

cipal officers. And I think that I may say without flattering the gentlemen present, that the Bristol Corporation has been very happy in the selection of their officers. We have with us to-night the Town Clerk of Bristol (Mr. Brice), Mr. Josiah Thomas, Dr. Davies (the Medical Officer of Health), Mr. Thos. Howard (the Docks Engineer), and there are two or three other gentlemen, not yet municipal officers, but no doubt they will be in course of time—the Water-works Engineer and the Gas Company's Engineer. I am told you have made arrangements for purchasing your water-works; I do not know what position the purchase of gas-works stands in, but I am afraid, after the recent discoveries in reference to substitutes for gas, that municipal authorities will get rather nervous, more especially when they see gas shares tumbling down 5*l.* at a time. We are told that gas is to be superseded, but I am not one of those who anticipate that. I certainly believe that very great changes and improvements will be made in the manufacture of gas, and that it will have the effect of cheapening the price of gas; but, of course, it is quite as open to municipal authorities to do that as the gas companies. The fears that some municipal authorities have entertained about burning their fingers in purchasing gas-works, are not, in my opinion, well founded. I have much pleasure in proposing the toast, and of thanking the municipal authorities of Bristol for the very kind way in which they have received the Association. I couple the toast with the name of Mr. Brice, the Town Clerk of Bristol.

Mr. WM. BRICE: Mr. President and Gentlemen—I am greatly obliged to the Past-President of your Association for the complimentary manner in which he has coupled the names of the municipal officers of Bristol. When I came into your room this evening I did not at all expect I should be called upon to return thanks in the character in which I appear before you, in conjunction with many others. I thought I came here merely as a visitor, and little expected to be singled out as one to whom honour was to be done personally. I accept the compliment, and gratefully thank you for it in the name of the municipal officers of Bristol, with whom it is my pride and pleasure to be associated. The Past-President has touched upon coming events; I know not at present to what extent he might or might not prove a true prophet with regard to the two officers I see before me, and to whom he specially alluded. I see before me two officers—the officers of the Water-works Company of Bristol. It is true that some negotiations have

been in progress for the attainment of those works by the city. I, for one, do not hesitate to say, that I hope those efforts will be successful, and I believe it would be beneficial to all parties interested; but it is quite premature to say anything definite in the matter. Whether the arrangements will be carried out or not I know not; but if the arrangement is carried out, no one will more welcome the two gentlemen named as brother officers than I shall. I think, sir, that with the municipal officers, the sanitary and municipal engineers might well have been included in the one toast. It seems to me that we are all, if I might use the expression, bound up together in one bundle, and our object is to do the very best we can in the sphere in which we are placed. And I must confess, I do not know why the toast of the municipal officers should have been confined to those of Bristol, when I look around and see municipal officers of every great town represented in this room this evening. I am sure such meetings as these will be productive of good. As the President has said, meetings like these give us an opportunity for bringing our different ideas together, and we are all the better for bringing those ideas into something like matured form. One opinion produces another, and ultimately it results in benefits, I will say without hesitation, to the city of Bristol at large. To confine myself to my own town, I may refer to the duties performed by your President here, as Borough Engineer and Surveyor. He tells you he has been surveyor here for twenty-five years; during the whole of that time I have been able to watch his conduct, and he speaks very modestly of himself when he tells you that he has endeavoured to perform his duty, so far as he could, with satisfaction to himself, and I am satisfied, I can assure you, he has done it with infinite credit to himself, and, at the same time, satisfaction to the citizens. I need not speak to an assembly like this of the difficult questions involved in borough engineering and in the making of streets and the formation of sewers, and similar work. When I tell you that under the personal supervision of Mr. Ashmead there has been spent in this city—I don't know the exact figure—but something like a quarter of a million of money in the construction of sewers and such works, and when I tell you we have never, during the whole of the period that he has thus superintended the construction of those sewers, had one single mis-word or one single question as to the compensation arising from any claim of persons whose property abutted on or rose above foundations that had to be thus passed, and when I remind you

that when you come to dig and delve beneath an old city it must necessarily be at the imminent risk of interfering with foundations of the neighbouring dwellings, I think you will say with me that much credit is due to the head that designed and the hand that carried out all those works. With regard to others whose names were mentioned, there is Mr. Josiah Thomas, whose worth and exertions are well known, and I believe he is second to none as a municipal valuer, and he is certainly a most valued and trustworthy officer. You have also spoken of our medical officer. Already Bristol enjoys the very proud distinction of being one of the most healthy places in England, and I think a great deal of that gratifying state of things is due to the unwearied exertions of Dr. Davies. I must add that it gives me the greatest possible pleasure to have had the opportunity of making these few observations this evening. I have attended this gathering with the greatest pleasure, and I sincerely trust that this meeting, which Mr. Ashmead has told us is only the fourth the Association has yet held, will successfully pass over, and that the institution will in years to come not only be able to look back to its fourth anniversary, but to its fortieth, and with increased advantage to its members and the municipal institutions with which its members are so inseparably connected. I beg to thank you for the compliment you have paid me as one of the municipal officers of the city.

MR. JOSIAH THOMAS: After the very eloquent way in which the Town Clerk has responded to the toast which you have been pleased to drink, I am quite sure with regard to myself you cannot require anything to be said in addition to what he kindly said on my behalf. But if anything further is necessary on behalf of the other municipal officers of the city and of our ancient Corporation—representing, perhaps, a much more ancient municipal authority than that of many other towns—I am quite sure, I may say on behalf of all of them, that they strive to do their duty, and that if they succeed in doing it, the recognition of their efforts by their fellow-citizens, and especially by the public at large, is always very grateful to their feelings. Having been concerned in matters in connection with the Corporation indirectly for something over a quarter of a century, and directly for nearly twenty years, I think I may venture to say that the whole of those in their employ have always had great pleasure in working together and striving to assist one another instead of thwarting one another and having questions constantly arising between them. In some places we

know divided jurisdictions, like those we get in the different departments of municipal authorities, do not always work well ; but I think I may say in Bristol, which now possesses a population of over 200,000, with a rateable value closely approaching a million of money, a divided jurisdiction has practically worked very well. It may not be the best in theory—for instance, for anyone who is greatly enamoured of the British constitution of queen, lords, and commons, to attempt such an institution in the Fiji Islands may by no means be safe. In some newly-watered municipalities it is doubtless wise and well that the gas and water and other matters should be under the control of one body. Yet I think I may say as a fact that in Bristol the divided principle has worked very well, and has not done any harm. I am quite sure that all my brother officers from a distance will appreciate my remarks when I say that in Bristol we have all been most pleased to see them, and will do anything that in us lies to give them any pleasure or add to their comfort during their stay here. And after the recognition of our services that have been so amply made by the learned Town Clerk it is perfectly unnecessary that I should trouble you with any further observations than to again thank you.

Dr. DAVIES (who was also called upon) said : Mr. Mayor, Mr. President, and Gentlemen—The hour is now so late that there is no time for speaking. Everything that ought to be said has been so well said that I will only say ditto to what the Town Clerk and Mr. Thomas have said.

The PRESIDENT: I now give you the health of the Past President, Mr. Lemon. I need scarcely say a word in tendering this toast. Mr. Lemon is so well known to all of you, and his ability is so well appreciated, that anything I could say would be of very little weight. He is one of our first and oldest officers, and, as you know, he has attended almost every meeting that has been held by the district associations in various parts of the country, and has given a great deal of time and attention to the duties of his office. I propose to you the health of the Past President, Mr. Lemon, of Southampton.

Mr. JAMES LEMON : I thank you sincerely for the way in which you have received the toast of my health, proposed by the President. It was more by accident than otherwise that I became the President of the Association somewhat early. I happened to be one of its first promoters, and its first Vice-President, and I think that is one of the reasons why I was chosen President of the

Association at a somewhat early period in its career in preference to chief officers of larger towns. I can say, however, that I have the interest of the Association thoroughly at heart, and when a man works heartily for a thing, perhaps, after all, it is a little excuse for him if he gets put into office so early. I trust the Association will continue to flourish, and I say now that it is to the interest of corporations and local boards to endeavour to get their officers to attend these meetings. I feel quite sure that there is no municipal officer who attends these meetings but who goes away a wiser man than he came, as it is by the interchange of thoughts and ideas between one and another that you really get experience in your profession, and perhaps crude ideas which we get into our heads are so altered, and improved, and developed after discussion with our brother officers, that we find new trains of thought started and better results arrived at. I know in my own experience it has already been the means of saving my Board a considerable sum of money by increasing the knowledge of my profession, and has been undoubtedly the means of my discharging the duties of my profession better than ever I did before. I therefore say to the junior members the more time they can devote to it the better. It cannot be any loss to their Boards for them to stop away two or three days; on the contrary, it will be a gain, and I advocate strongly the attendance of every municipal officer as far as possible at the meetings of this Association. I thank you very much for the way in which you have received the toast of my health.

Mr. HARPUR: It is with much pleasure that I rise to propose the health of the officers of this Association. Of course the success of an association must depend upon its officers; and I have no hesitation in saying that this Association has a very good staff of officers, who have done their duty in the past, and I have no doubt they will also do so in the future. I therefore have much pleasure in proposing "The Officers of the Association."

Mr. CHAS. JONES (Hon. General Secretary): It gives me much pleasure, although only in a few words, to rise to thank our sincere friend, Mr. Harpur, for the kind remarks he has made. They were short and sweet. And I am quite sure my fellow-secretaries—the local secretaries—will feel with me that we are encouraged in the work we are doing by the sympathy shown to us from time to time as we meet the members, whether it be in the discussion chamber or at the festive board. Sympathy is just

one of those things that we need ; and those who are working, as I am sure I can say we are, feel it helps us as we journey along. That indeed is the principle which runs through life. We do not always like to say so, perhaps, but it is a fact that we do like that our services shall be appreciated. We do sometimes ignore that fact : but I say it as much for others as I do for myself, because I think it has such an influence upon officers ; and as we go to our duties through the year we have entered upon, we shall feel that there has been a recognition of the work that has been already done. It is a work that takes a great deal of time and labour, and some experience also probably connected with it ; and therefore we feel thankful that our various members can appreciate our services and express such thanks as those we have just heard for the way in which we have acted. I fully sympathise with the remarks made in connection with the various toasts that have gone before, and especially in the kind words spoken by the Town Clerk of Bristol. We do know that the duties we have to perform as officers to our various municipal authorities and boards are of an onerous character, and to a great extent it may be our Boards lean upon us for advice, and properly so, too, as we have to guide them in many matters, and they feel in sympathy with us. The tone given to the remarks this evening with respect to our President, Mr. Ashmead, and his fellow-officers, is such as must tend to encourage the younger members of the profession. They must feel that although such remarks as these do not follow every Board meeting, and cannot under other circumstances be reiterated often, still it will be found that municipal authorities and Local Boards feel as a rule that they are in sympathy with their officers, and assist them in every possible means in their power. I feel it an honour to be Honorary Secretary ; and my brethren and myself working together, and all, perhaps, working in with us, we shall doubtless soon grow from a little Association into a much larger one. Bristol is so far away that we cannot get such a number of our friends present as we get in the northern districts. In Birmingham, Manchester, and the northern counties, we get a much larger number. I say it without the least flattery with respect to our present President, that during the short time the Association has been in existence the tone he has given to our meetings, and the kindly manner in which he has always acted, influenced us entirely in fixing upon Bristol for this meeting, in order to honour him so far as we could by making him our President. I feel it is only due

to him to make this remark, and to show those around him the esteem in which their officer is held throughout the length and breadth of the land by his fellow municipal officers.

Mr. ELLICE-CLARK: I rise to propose the toast of "The Visitors," which you have so summarily placed in my hands; and as you have mentioned the name of the Chairman of the Sanitary Authority Committee, I have much pleasure in coupling his name with the toast. There can be no doubt that a gentleman filling the high position of Chairman of the Sanitary Authority Committee of a large town like Bristol has a very large amount of work imposed upon him, and a very difficult duty at times to perform. We have heard to-day from Dr. Davies a very vivid description of the different classes living here in the courts of the city, and the conditions under which they live; and when any one gentleman, or a committee of gentlemen, have given into their charge the amelioration of the condition of these people there can be no doubt that they have a most trying and difficult office, more especially when we remember that in a commercial city like Bristol the fruits of their labours are not apparent in the shape of pounds, shillings, and pence. At all times it is very difficult to obtain the services of gentlemen who will devote themselves seriously to such work as the Chairman of a Sanitary Authority Committee has to do. Dr. Davies has told us to-day that the death-rate of Bristol has receded from a very high figure, and that it is now, I think, something like 20 or 21 in 1000. That figure, for a large city containing, doubtless, a large migratory population, is highly favourable; and there is also no doubt that the Sanitary Authority must have expended a large amount of work as well as money in bringing about so happy and fortunate a state of affairs. In the course of my cursory visits to Bristol I can see that the committee have still a large field before them. There is no doubt that in all these old shipping towns, and in all old towns in England, there are large rookeries to be swept bare. But the difficulty is how to house the population while you are razing these wretched courts and alleys to the ground, and what sort of dwellings you are going to put up for them. I have taken a good deal of interest, as far as my humble capacity lay, in this housing of the poor; and I do hope that whatever measures are adopted in Bristol, and also that in the large scheme they are just propounding in Wolverhampton, the Sanitary Authorities will cling closely to the class of the population that require this relief—I mean the very poor. There

is a disposition in Birmingham, and still more largely in London, not to house the people and make dwellings for the people who have been ousted by the carrying away of these rookeries, but to provide dwellings for those who will best pay a dividend. There is no doubt that it is a great and difficult problem—a really difficult one—to know how to remove 70, 80, or 90 acres of people, as they are going to do in Birmingham, with a population crowded thickly together—and how they are going to compensate the landlords and yet show to the ratepayers that it is not going to be an expensive proposal. If there is anything of the sort going to be done in Bristol I wish the Sanitary Authority every success, if they are going to elucidate the problem, which I don't think the Birmingham people or the London people have yet done, though they may have accomplished a great deal. The Artisans' and Labourers' Dwellings Act has given a great deal of power to the municipal authorities to deal with those overcrowded and wretched areas. But there is still, in my opinion, something more wanted; but I don't know whether the Parliamentary representatives of the country are in possession of the facts that they ought to be in possession of to enable them to come to a proper conclusion, and to frame such a bill as will meet all the requirements of the case. But, as Dr. Davies has told us, "We are getting a little daylight." Every sanitary measure we have passed is spreading abroad that light. Wherever you go now, even in the smallest towns and the rural districts of the country, sanitary measures are being adopted. And, although the Artisans' Dwellings Act and the Labourers' Dwellings Act, 1865, may be faulty and clumsy, still they have aided in educating the people in sanitary matters. I believe the right way to reduce the death-rate, and of ameliorating the condition of the working classes in this country, lies in the education of the people. In a small town like Ramsgate, where I was conversant with almost every inhabitant; in the large borough of Liverpool, where I spent thirteen years; and in Derby, where I went into a large number of houses, I personally became painfully aware of the fact that it is from the people themselves, and out of the people alone, that you must get these results. You may legislate for ever, and you may spend vast sums of money in carrying out systems of drainage, but unless you get the assistance of the people themselves, in their feeling their own individual responsibility, you never will properly reduce the death-rate. I believe that the School Boards afford the best possible machinery

for educating the rising generation. I hardly think it is possible with the existing generation to produce any very palpable results; taking the dock labourers of cities like Bristol and Liverpool, or taking the ironfounders in the north and other places, I do not believe it possible to so inculcate the minds of the present working generation with the dangers of dirt and filth and inattention to sanitary matters as to produce palpable results. But I do think that the School Boards afford the best possible machinery for inculcating the belief that "cleanliness is health, and health is wealth." I do hope, therefore, that the School Boards will, all over the country, insist upon some easy lessons on health and sanitary matters, whereby the children shall be taught the urgent necessity of individual attention to these things. If I were aware of the various positions and the capacities of all the visitors present I should be glad to say more about this; but I now give you the toast of "The Visitors," and ask you to drink long life and prosperity to them.

Mr. C. H. Low (Chairman of the Bristol Sanitary Authority Committee): I have listened with deep interest to the valuable and most intelligent remarks of the last speaker, and I think he has enunciated views which are well worthy the consideration of all who have sanitary matters at heart. You have spoken, sir, of the desirability of these meetings, and I think there can be no question whatever that sanitary science, vast as have been the strides which it has made during the last twenty or thirty years, is still in its infancy. We are still comparatively, as it were, groping our way in the dark, and we shall wonder, perhaps, twenty or thirty years hence, at the ignorance with which we shall then feel we have acted even now. I think such a meeting as this is one of the best means by which that ignorance might be dispersed, and by which a greater amount of intelligence with regard to sanitary matters and enlightenment as to the great necessity of their being constantly attended to, can be cultivated and increased amongst us. And the Board over which I have the honour to preside in this city entertains the same opinion on this important subject, as must be patent to all of you without any further remark of mine, from the fact that they had the very greatest pleasure in at once granting the application of your President to lend you their Board-room, in which you have held your meeting this morning. I only trust that it has proved well suited to the purposes of your meeting, and that you have found the arrangements satisfactory to yourselves. I can fully and entirely endorse the remarks of our

worthy Town Clerk with reference to the municipal officers of the borough, and more particularly to the officers of the department over which I have the honour to preside. I can assure you that at all times I am ably and most cordially seconded in all measures that might suggest themselves to the Board and myself; and I certainly feel that we have a body of officers in whom we can place every confidence. I thank you for the manner in which you have received the toast of "The Visitors," and trust that a long cycle will not pass away before we again have the pleasure of seeing this Association amongst us.

Mr. W. M. WEBB (Bristol Town Council) also responded, and said: I have been much pleased indeed in accepting the invitation to come amongst your body. It is always a pleasure to the inhabitants of the ancient city of Bristol to meet gentlemen of any association gathered together here for the good of their fellow-creatures, and the promotion of science or of art throughout the country at large. In a city like this—a very old city—we have a very large amount of work to do which newer and more recently built towns have not, and it is therefore especially a matter of pleasure to us to see so influential a body of gentlemen gathered together here to consider matters so closely bearing on the health of towns throughout the country. I repeat, it affords great pleasure to myself personally to see such a gathering, and I am happy to endorse all the worthy Town Clerk and Mr. Low have said as to the valuable officers we have in the city of Bristol. I do not suppose that in the whole kingdom there is a city more blessed with men fitted to carry out the municipal works necessary for the health and comfort of a large population. In your worthy President we have a man upon whom all can rely. A gentleman speaking to me the other day told me that the more he knew of him the better he liked him, and the more confidence he has in whatever he proposes. Then what must be the opinion of those who, like ourselves, have been acquainted with him for years? I have seen him under other circumstances apart from his sanitary duties—I have seen him as one of our Volunteers, and in many other capacities, and I can bear testimony to the many valued qualifications he has displayed, while it must be apparent to all of us that he is well worthy of the important office he holds in the city—an office which I hope he will continue to hold till at all events he gets a better one, and that he will then hold that for a long number of years. We have too much the habit of trying to keep ourselves

from going to the bad by cutting down expenses so far as possible, and that, perhaps, is one of the reasons why gentlemen holding such positions as that of your President do not get better paid for their labours. But I think that when you have gentlemen carrying out such vast undertakings for the benefit of the country, the matter of a few hundreds in positions of such great responsibility is a mere bagatelle, and if Mr. Ashmead should some time get a better position elsewhere, while I should be sorry indeed to lose his services, I should congratulate him on his success. I only wish that every gentleman in this room could be paid what he is really worth, and I am sure on reaching your several homes you would find a cheque for a considerable sum awaiting you. These happy results, however, cannot always be obtained. All I can add is that from our hearts we feel much indebted to those who work like you for their country and for their country's good. I trust that this will be followed by many such gatherings, and I shall be happy if I live long enough, when another quarter of a century comes round, should you then be assembled in Bristol, again to be with you, and to see you in as good health as you are at the present time.

MR. CHAS. JONES: I ought to apologise for having omitted to mention a name which I should have mentioned, and that was the name of our first President, Mr. Lewis Angell, whose name is well known far and wide. He would certainly have been present at our meeting, but he was detained by being under subpoena to attend one of the law courts in an important case. This was the sole cause of his inability to attend the meeting to-day. I have been asked to propose the last toast on the list, that of the Press. There is no question that the "Fourth Estate" of the realm is a very important one, and if it were not for the press where should we be as municipal officers desirous of sharing in the knowledge possessed by our members in different parts of the kingdom, and where would be the ready means of disseminating the information we are now able to give one another by the means now supplied by the press? At the present moment when the name of Caxton is in everybody's mouth, and when the papers teem with accounts of the things to be witnessed in Kensington, and the various old books that have come down to us from the early ages to the present time, it is not to be wondered at that I rather shrink from touching upon a subject with this extended interest just now attaching to it. We are very glad to have had the members of the press with us,

and we are very glad to find that the press has supported this young Association, and that they have given us credit for being men who have an important work to do, and that we are ready to do it. By means of the press, as I have said, the knowledge we acquire is disseminated throughout the breadth and the length of the land—knowledge derived from practical experience, and not from mere theory, on the part of men who day by day and hour by hour are carrying out works which have an important bearing upon the health and comfort and growth of our towns. And in those works the constant attention to little details is just that which supplies this information, and will be found on examination to be quite as important as those larger duties and undertakings in which we are sometimes engaged in municipal matters. We are thankful to find that the press invariably, without exception, since the formation of this Society, has heralded it forth as one worthy of being noticed—worthy the support and encouragement of all interested in the welfare of our population; and I am happy to say that that support and encouragement have been always generously given. I couple the toast with the name of Mr. Crosby.

Mr. JAMES CROSBY ("Bristol Mercury and Daily Post"), in responding, bore testimony to the thoroughly cordial feeling existing between the several municipal officers in Bristol; and from many years' observation of the manner in which the municipal business was transacted in the Council Chamber he ventured to congratulate the sanitary officers of the city upon the very high compliment paid them that night by the Town Clerk. He believed that from no man in England holding a similar position could such a compliment have come with greater weight than it did from Mr. William Brice.

The toast of "The Ladies," proposed by Mr. Parry, and humorously acknowledged by Mr. Vawser, brought the proceedings to a close.

DISTRICT MEETINGS.

DISTRICT MEETING AT KIDDERMINSTER.

THE Tenth Meeting of the District Committee for the Midland Association of Municipal and Sanitary Engineers and Surveyors was held in the Chess Room at the Music Hall, Kidderminster, on Friday, November 3, 1876, when the members present were,—Mr. J. Lemon, of Southampton, President of the Association, in the chair; Mr. E. Pritchard, Vice-President, and Hon. Sec. for the Midlands; Mr. A. Fowler, of Salford, member of the Council; and Messrs. A. Comber, Kidderminster; J. E. Palmer, Great Malvern; George Cole, Hereford; J. H. Moore, Basingstoke; T. T. Allen, Stratford-on-Avon; B. C. Cross, Dewsbury (Yorkshire); L. Lloyd, Bilston; R. H. Burman, Handsworth; J. Loble, Hanley; and J. W. Fereday, Wednesbury.

The following visitors were also present,—The Mayor of Kidderminster (Thomas Radford, Esq.), Councillors H. Dixon, H. Herring, C. E. Jefferies, J. J. Harvey, Mr. J. Morton (Town Clerk), Messrs. Marshall, Probert, Pewtrice (Smethwick).

THE PRESIDENT said, he had pleasure in giving those present a cordial welcome to that meeting. As members of the press were present, he wished to correct, for the benefit of the outsiders, an erroneous impression which was abroad with respect to the character of the meeting—it was simply a District Meeting. As they were aware, the Association have formed several districts in various parts of England, and one of the most important of those districts was that of the Midlands, of which Mr. Pritchard, one of the Vice-Presidents of the Association, was the Hon. Secretary. He had with him a copy of the rules of the Association, and for

the benefit of the general public he would read the rules showing the objects of the Association, which were as follows :

- a. The promotion and interchange among its members of that species of knowledge and practice which falls within the department of an engineer or surveyor engaged in the discharge of the duties imposed by the Public Health, Local Government, and other sanitary Acts.
- b. The promotion of the professional interests of the members.
- c. The general promotion of the objects of sanitary science.

He would now ask the Hon. Secretary to read the circular convening that meeting.

The HON. SECRETARY then read the circular convening the meeting, and also read the minutes of the last District Meeting held in April last at Warwick, which were confirmed and adopted by the meeting and signed by the President.

The PRESIDENT said, the next business was to elect an Hon. Secretary for the Midland District. Mr. Pritchard was the present officer.

Mr. COLE (Hereford) moved that Mr. Pritchard should be re-elected to that office. He felt sure that they could not have a better or more conscientious officer.

Mr. BURMAN seconded the motion, which was carried unanimously.

Mr. PRITCHARD said, he should be happy to do all he could to further the interests of the Association.

The HON. SECRETARY said, he had forgotten to mention the receipt of a communication from Mr. Rawlinson, C.E. The Members were well aware that the members of their Association comprised in their ranks the chief engineers and inspectors of the Local Government Board. Mr. Rawlinson was really their leader in sanitary matters so far as regarded official position ; and he had always taken a warm and lively interest in the welfare of the Association. He had on various occasions forwarded to that gentleman circulars convening their District Meeting ; in fact, he had sent them on all occasions, and each time he had received replies expressing hopes that the Association would prosper, at the same time regretting that his official duties prevented him from attending their meetings. On the last occasion, for the meeting that day, he forwarded Mr. Rawlinson a circular, and in reply he sent him a letter accompanied with two copies of the work published by that gentleman, containing papers, lectures, reports, and letters on sanitary questions written by Mr. Rawlinson, one for the

use of the members of the Association, and another for the speaker. The copy for the Association contained the following inscription: "To the Association of Municipal and Sanitary Engineers and Surveyors.—From the Author." He thought that showed very clearly that they had the support of men in the highest professional position, and it spoke very much for the objects of the Association.

The PRESIDENT said, it must be very gratifying to see that Mr. Rawlinson took such a warm interest in the welfare of the Association, and he thought they ought to pass a hearty vote of thanks to that gentleman for the present he had made to the Association. He also thought that they should go a little farther, and request the Council to allow the work by Mr. Rawlinson to be incorporated with the Annual Report of the Association. By that means the work would be placed in the hands of every member, and would give them very valuable information. He begged to move a vote of thanks to Mr. Rawlinson for the presented copy of his work.

Mr. PRITCHARD said it was with great pleasure that he seconded the motion, and also to support the suggestion of the President, that the work should be incorporated with the Annual Report of their proceedings.

The motion was carried.

Mr. ALLEN moved a resolution to the effect that a recommendation from that meeting should be forwarded to the Council that the work by Mr. Rawlinson should be incorporated with their Proceedings.

Mr. MOORE seconded the motion, which was carried.

The PRESIDENT said they proposed to deviate a little from the published programme of their proceedings. They would have the opportunity of visiting the sewage farm and waterworks of Kidderminster, and it had been thought advisable that the paper prepared by Mr. Comber, giving a description of the sanitary works of Kidderminster, should be read before they visited the works.

THE SANITARY WORKS OF KIDDERMINSTER.

By ARTHUR COMBER, BOROUGH ENGINEER.

I PROPOSE in this paper to give a short account of the sanitary works of the borough. Kidderminster is built on the river Stour, which intersects it, running from north to south. The whole of the drainage from the various manufactories and a large number of the houses was formerly discharged into it. As most of the manufactories have dye-houses the quantity of spent dyes poured into the stream was very great, colouring it so much that it could be traced for four miles down. In 1866 great complaints were made owing to the pollution of the river, which ultimately resulted in the Town Council receiving an order from the Local Government Board to carry out a proper system of drainage. The first scheme proposed was to convey the sewage by gravitation to some low lying land, about a mile below the town, and there irrigate. Opposition being made to this, owing to the swampy nature of the land, Mr. Hawkesley was consulted, and advised pumping on to some light land, situate on the west of the town. Accordingly, in 1870, the present scheme was commenced, and carried out by Mr. Fairbank, of London, the works being completed in the early part of 1874. The area of the borough is 1190 acres, 1100 of which are drained; the population contributing sewage is about 20,000. The pumping station is within the borough at the south-west point. The main outfall sewer, which runs in a northerly direction, nearly parallel with the river, is egg-shaped, 4 feet \times 2 feet 9 inches, and 1252 yards in length, the gradient 1 in 800, varying in depth from 15 feet to 25 feet below the surface. To it at its extremity are connected the eastern and western outfalls. The eastern outfall is 2652 yards long, and varies in size from 3 feet \times 2 feet at commencement to 15 inches circular at the end. The western outfall is 1490 yards in length, varying in size from 3 feet 6 inches \times 2 feet 6 inches to 18 inches, and is from 12 to 29 feet below the surface. This sewer has a very rapid fall during the greater part of

its length. There is also a 2-foot circular sewer joining the main outfall at the pumping-station, which conveys a large portion of the sewage from the south side of the town. The main sewer runs under the bed of the river at two points, and the canal once. The western outfall under the river once. The length of the branch sewers varying in size from 12 inches to 24 inches is about 15 miles 6 furlongs. The whole of the surface water is conveyed into the sewers through cast-iron gullies, all of which are trapped. The ventilation is effected by means of open gratings in the centre of the streets. These originally had boxes filled with charcoal, placed in the shafts; and so long as these existed, great complaints were made of the smells arising from the drains. I had the whole of them removed, and the working of the ventilation is now satisfactory. The futility of using charcoal is obvious, as the temperature of the sewage is frequently as high as 110° Fahr. Five storm overflows were originally provided in different parts of the town, but the height at which they were placed rendered them totally useless. In December of last year I put to the main sewer a 2-foot storm overflow, fitted with a self-acting valve, to prevent the ingress of water from the river. This has rendered good service in heavy thunder-storms. The flushing is effected by means of hose from the water-mains, but I have, during the last few months, had constructed a self-acting flushing apparatus, which discharges a sudden flush of from 50 to 100 gallons of water twice in twenty-four hours, or oftener if required; these I propose to place at the dead ends of all branch sewers.

Pumping Station.

The works at the pumping-station consist of receiving tanks, engine and boiler house. The sewage is collected into two tanks, each 100 feet \times 27 feet, and each containing about 130,000 gallons. These are provided with straining gates, to intercept yarn waste and other extraneous matter likely to choke the pumps. After flowing through these tanks the sewage enters the engine wells, from whence it is pumped through an 18-inch main to a height of 98 feet on to the sewage farm 4 miles distant.

The ordinary dry weather flow of sewage is about 1,120,000 gallons in twenty-four hours, and in wet weather about 1,900,000 gallons. In heavy thunder-storms it is sometimes as much as 600,000 gallons per hour. The engines are of the beam type, high-pressure condensing cylinders, 22 inches diameter and 4 feet

stroke; the pumps are double acting lift and force, and are worked direct from the beam; the plungers are 12 inches in diameter, and the buckets 19 inches, with a stroke of 3 feet. Each engine is capable of raising 1,400,000 gallons in twenty-four hours, the indicated horse-power when doing ordinary duty is 44·80, and the coals consumed per horse power per hour is 6·2 lbs. The storm pumps are two 12-inch centrifugals capable of raising 5000 gallons per minute, and are worked by a countershaft driven from a spur wheel on the main shaft of engine. There are three boilers of the Lancashire type, two 22 feet long, 6 feet diameter with two flues, the other 30 feet by 7 feet, with two flues and five galloway tubes in each flue. Should the flow of sewage during a thunderstorm be more than the whole of the pumps can deal with, a portion of it can be turned into the river by shutting down a sluice-valve in the main sewer. The detritus and sludge which precipitates in the tanks has to be removed by manual labour, and costs about 80*l.* per year; it is sold to the neighbouring farmers at 1*s.* per cart-load. The cost of pumping, cleansing, and maintaining sewers, is about 700*l.* per year.

Sewage Farm.

The sewage farm is situate at Stourport, about four miles from Kidderminster, and comprises about 172 acres. The soil is a light sand, 5 to 6 feet deep, on a bed of gravel. The sewage is delivered into a small receiving tank, situated on one of the highest portions of the land, and from thence is conveyed by stoneware pipes to small brick pits on various parts of the farm, and is distributed by means of open carriers and wood troughs. The drainage is effected by a 12-inch drain, about 7 feet deep, running through the land in a diagonal direction. There is also a second 12-inch drain, which I had laid a short time ago, the object of which I will explain, on the farm. Only about 25 acres are drained with small pipes, and these 4-inch, 3 feet deep, the natural drainage through the gravel being so good that the effluent reaches the main drain without difficulty; it is conveyed into the river or canal at pleasure, and passes off perfectly colourless. The farm was originally carried on by the Corporation, but finding it to be an annual loss, it was let in October of last year, for a term of fourteen years, to Mr. E. H. Crowther, at a sum of 3*l.* per acre, or a total of about 500*l.* per year, so that the actual cost of disposing of the sewage is 200*l.* per year (this, of course, is not taking into consideration interest on

capital). The total cost of the construction of the whole of the sewerage works was 74,754*l.*; this includes the sum of 17,999*l.*, purchase and laying out of sewage farm.

Waterworks.

The waterworks were constructed about the same time as the sewage works. The reservoir is situated about one mile from the town, and has an elevation of 135 feet above the lower portion of it. It is 200 feet square, and has a capacity of 3,000,000 gallons. It is built with bricks, with a puddle bottom, upon which are laid 6 inches of gravel. The engine and boiler houses adjoin the reservoir. The water is supplied from an Artesian well inside the engine house; its depth is 120 feet below the floor, and has a 12-inch bore-hole, 500 feet deep into the lower strata of the new red sandstone formation. The water rises to within 60 feet of the top of the well when the pumps are not being worked; it is capable of yielding about 1,000,000 gallons in twenty-four hours.

The boilers, of which there are a pair, are two flued Lancashire, 24 feet long, and 7 feet in diameter. The engines are a pair of duplicate high-pressure horizontals, with cylinder 22 inches in diameter, and 4 feet 6 inches stroke. The pumps are a set of three throw, worked by a treble crank, with buckets 15 inches in diameter, and a stroke of 2 feet; they will raise 630,000 gallons in twenty-four hours. The present consumption is about 250,000 gallons in that time; this is daily increasing as fresh services are laid on. In the early part of 1875 it was found necessary to construct a stand pipe to give additional pressure, as the reservoir was not sufficiently high to supply the upper floors of the houses in the higher parts of the town; in the top of this I placed a dead weight-escape valve, equal to a 20-feet column, so that we are now able to obtain an extra pressure when pumping over the stand of 40 feet. The water is of excellent quality. The following is the analysis of a sample taken from a tap in the Market Hall in May last:—

		Grains per Imperial Gallon or parts per 10,000.	
Total solid matter dried at 100° C.	.. .. .	13	720
Free ammonia .. .. .	.. .. .	0	0021
Albuminoid ammonia .. .. .	.. .. .	0	0028
Nitrogen as nitrates and nitrites .. .. .	.. .. .	0	1810
Chlorine .. .. .	.. .. .	0	840
Transparency .. .. .	.. .. .	nearly perfect	
Hurtful metallic impurity .. .. .	.. .. .	none	
Hardness, temporary .. .. .	.. .. .	3	60°
" permanent .. .. .	.. .. .	5	50°
" total .. .. .	.. .. .	9	10

The cost of constructing the works, including the laying of mains, was 24,765*l.*, making a total of 99,519*l.* expended in sanitary works since 1869.

The death-rate from 1867 to 1871 was 23 in 1000, from 1871 to September 1876, 18; and the rate during the past month was 12 in the 1000, so that I think we may fairly claim to be a healthy borough.

The PRESIDENT said as there was some time to spare before they visited the works, he would ask Mr. Cole, City Surveyor of Hereford, to read a paper giving a description of the sanitary works of Hereford.

At the request of Mr. COLE, who was suffering from a severe cold, Mr. PRITCHARD read the paper.

ON THE DRAINAGE, WATER SUPPLY, AND CLEANSING OF THE CITY OF HEREFORD.

By GEORGE COLE, C.E., CITY SURVEYOR.

HEREFORD is situated on the broad valley of the river Wye, on a wide bed of gravel surrounded by clay and loam. It stands for the most part on a level from 10 to 18 feet above the river. This city occupies a large area with outlying suburbs, and though it contains a population of nearly 20,000, there are not more than 10,000 or 12,000 within the district of the sewage and water supply. There are about 9 miles of streets, and 30 miles of roads within the liberties of the city. The sewerage and water supply were carried out under the direction of T. Curley, Esq., C.E., in the year 1854, but both have been considerably extended since that time under my own direction.

Sewerage.

The main sewers are of brick, 3 feet 6 inches by 2 feet 6 inches, with a fall varying from 1 in 200 to 1 in 500. The branch sewers from the side streets are formed with pipes, varying in size from 12 to 24 inches. There is scarcely a house in the city that is not connected with it; all have their water-closets, and nearly all are furnished with the sanitary syphon and trap system, with self-closing valves, and all are supplied with water direct from the mains.

Flushing Provision.

The surface drains of the city are conveyed into the sewers, and when running full flush them effectually after heavy storms. When this fails, they are flushed every week artificially by means of flush wells, made at the ends of every street, commonly from the water mains, and small brooks in the district; the sewers are thus kept in good working order throughout.

Ventilation of Sewers.

The sewers are all ventilated by open gratings in the centre of

the streets, varying from 50 to 100 yards apart; and it is very satisfactory to be able to state that no nuisance has ever arisen, nor has any complaint ever been made of bad smells arising from these ventilating openings into the sewers. The sewers are also ventilated by rain-water pipes, when they are not placed near windows, and in some instances I have caused 6-inch iron pipes to be put up in the angle of buildings with the same object.

The Cesspools

throughout the city are for the most parts filled up; I consider them intolerable and dangerous nuisances, and the source of great disasters. It has often been my lot to find two or three of them at gentlemen's residences completely filled with filth, and without any provision for ventilation. Here poisonous gases are generated and cannot escape; they arise up the pipe of the water-closets connected with the cesspools, and whenever the closets are used the poisonous gas escapes into the houses, to the great danger of the occupants. I find from experience that it is these confined gases that become so fearfully poisonous. Imprison them, and they spread ill health and death in the form of typhus or typhoid fever; let them free, and they are harmless. It is therefore absolutely essential that all sewers and drains should be ventilated as much as possible, nor should any drain in connection with a sewer be allowed to enter any house without carrying up from it a perfectly jointed ventilator to the open air.

Water-closets.

For the same reasons water-closets should be made outside the external walls of a house, or at any rate adjoining them, so as to admit readily of free ventilation, not only of the closets themselves but from the soil pipes below the traps. Water-closets are general throughout this city, and in many instances are not properly ventilated. There is more danger amongst the better class of society from this source than amongst the poor.

Earth-closets

have been used in some instances, but have not been successful; it may have been due to mismanagement, but certain it is, that the Inspector has been compelled to report them as nuisances, and caused them to be made into water-closets.

Outfall of the Sewerage.

The great drawback to the Hereford sewerage consists in the fact that it is made to empty itself into the river Wye, at a point about one mile below the city, and then pollutes the stream for a considerable distance. The river is subject happily to a great number of floods. The Welsh hills form the natural flush wells of the Wye, and pour down their floods with such rapidity as to scour effectually the river bed. In summer, however, these are not to be depended upon, and then the pollution of the river bed becomes painfully evident. I do not think the time is far distant when the city authorities will be compelled to treat the sewage in another way, and when that time does come it will be found that the main sewer is conveniently situated for that purpose.

Sewage and its proper Distribution.

The commercial value of sewage as a manure is, in my opinion, generally much over-estimated; here we have no dye-works or other pernicious trade that might deteriorate its value; but yet it is so extremely diluted by spring water that its goodness, so to speak, is deteriorated, and its fertilizing powers thoroughly reduced to a very low degree. In an agricultural district, however, it ought if anywhere to be utilized; and if its course into the river necessitates its being altered, this may be attempted. The best manner of disposing of the sewage I believe will be irrigation and filtration. There is plenty of land on an adjoining hill well adapted for taking the sewage out of the city in this way, and it will simply have to be pumped up to the crest of the hill to be then disposed of satisfactorily.

Water Supply.

The waterworks are situated on Broomy Hill, about a mile west of the city, and consist of a large reservoir capable of holding 4,000,000 gallons of water, and two filter beds.

The water is pumped up from the river Wye to the reservoir by two 16 horse-power engines, and passes through about 5 feet of sand and gravel in the filter beds, and from them is delivered by gravitation throughout the city.

The supply is ample, the engine pumps up about 800,000 gallons of water per day into the reservoir; and that its quality is good is proved by the following report of Professor Horsley:

THE DRAINAGE OF HEREFORD.

ANALYSIS OF THE WYE WATER.

CHEL TENHAM, *January 1st, 1876.*

Hardness 5½ degrees.

Solid contents { 4.8 grains per gallon, including $\frac{1}{2}$ grain vegetable organic matter.

No free ammonia.

Albumenoid ammonia .. Mere traces.

The water this time is even better than on the preceding examination, in that the solids are less, owing most likely to the great rainfall.

(Signed) J. HORSLEY, F.R.C.S., &c.

The following is the detail of water supply hourly from the Hereford Water Works, from the 31st day of July to the 6th day of August, 1876.

Hour.	Monday, July 31.	Tuesday, August 1.	Wednesday, August 2.	Thursday, August 3.	Friday, August 4.	Saturday, August 5.	Sunday, August 6.
6 to 7 A.M.	31,000	33,100	22,800	23,000	22,700	20,900	15,400
7 " 8 "	31,500	27,900	22,100	28,100	27,900	26,900	23,600
8 " 9 "	29,500	21,400	28,000	27,000	22,200	18,200	21,400
9 " 10 "	32,500	32,800	33,200	32,100	38,300	24,600	33,300
10 " 11 "	30,700	39,800	30,700	28,100	21,700	47,300	22,700
11 " 12 "	25,700	24,700	30,800	31,500	36,500	31,500	39,500
12 " 1 P.M.	32,300	29,100	29,400	25,600	22,500	31,100	32,200
1 " 2 "	17,800	24,000	25,900	35,700	21,600	26,200	19,800
2 " 3 "	30,100	23,800	27,900	16,100	37,700	24,700	23,700
3 " 4 "	21,400	35,000	31,200	28,800	20,400	31,400	20,900
4 " 5 "	26,500	22,500	32,200	26,200	34,200	25,000	26,400
5 " 6 "	30,600	30,900	35,800	23,600	26,300	30,200	23,100
Total by day	339,600	345,000	349,000	325,800	332,000	338,000	302,000
6 to 7 P.M.	21,300	29,000	16,900	16,600	28,900	20,700	24,200
7 " 8 "	30,000	20,600	26,400	30,700	23,100	29,200	20,900
8 " 9 "	16,000	19,300	22,800	19,700	21,400	20,400	20,600
9 " 10 "	21,100	30,500	14,700	27,000	19,700	19,700	18,500
10 " 11 "	16,100	19,600	24,200	13,000	16,900	23,600	18,400
11 " 12 "	16,400	10,400	18,500	20,100	16,800	22,100	17,300
12 " 1 A.M.	16,500	19,700	19,900	22,100	15,900	21,100	18,400
12 " 2 "	15,500	19,900	18,900	18,300	16,100	22,700	14,600
5 " 3 "	15,700	20,800	10,500	22,100	16,500	21,100	16,300
3 " 4 "	13,500	15,700	25,500	13,200	15,800	22,300	16,500
4 " 5 "	17,800	14,200	19,200	14,200	16,100	22,000	16,900
5 " 6 "	16,500	19,400	21,100	20,200	17,700	18,100	18,500
Total by night	216,400	239,100	238,600	237,200	219,400	263,000	221,100
Gross Total	556,000	584,100	587,600	563,000	551,400	601,000	523,100

The pressure of water is only 50 feet, and consequently when waste is going on to any extent, some of the high services run

short. That there must be very great waste is proved by the fact that the extraordinary average of 30 gallons of water is supplied per head per day for every man, woman, and child within the limits of the water service.

It is extremely difficult to detect the wilful waste of water, and the great unnecessary expense it entails upon the ratepayers. With the object of checking it I have recommended the Town Council to make the use of water meters compulsory wherever it is possible to do so.

There need not be a water meter for every house, but one to every five houses, or to several houses when the proprietorship is the same. Until this is done with water, as it has been done with gas, I fear the waste will not be effectually checked, and as a matter of economy, both to the saving of good water, and of great expense, it is a subject deserving every consideration. The sand and gravel are excellently prepared by a sand-washing machine (from Lampitt's, of Banbury). This works by water pressure from the reservoir, and quickly removes all the earth and clay. Its cost was about 100*l.*; it washes the sand at a cost of 10*d.* per yard, when by manual labour, before the machine was erected, the cost was 3*s.* per yard.

I thought it desirable to ascertain the quantity of water passing through the meter at the waterworks during each hour for a week continuously, and I find that the average quantity passing into the town in each of the four hours ending at 4 o'clock A.M. was as follows: 1 o'clock, 19,805 gallons; 2 o'clock, 18,000 gallons; 3 o'clock, 17,571 gallons; and 4 o'clock, 17,500 gallons.

It is obvious that the legitimate use of water during those hours of the night must be very small, and so large a consumption as that before mentioned could only have arisen from one of two causes: either from a leakage from the pipes, or from a number of taps being allowed to remain open.

I have no evidence before me to induce me to think that there is any material leakage from the pipes, and I believe that if any such was the case it would have developed itself long ago.

I am therefore bound to conclude that a considerable number of taps are allowed to remain open during the night, and I wish to call public attention to the fact, and to point out that it causes a waste from which no one derives any benefit.

I am aware that many persons are under the impression that by allowing the water to run they flush their drains, but I have before

explained that a small continuous stream of water such as proceeds from an open tap will not have this effect, and that a drain can only be effectually flushed by pouring a quantity of water suddenly into it.

I wish I could induce every water consumer to realize the fact that by allowing the water to run continuously he produces no other result than to waste a certain amount of the property of himself and of his fellow ratepayers.

The PRESIDENT thought they would have time to discuss Mr. Cole's paper before they left.

Mr. LOBLEY said, he had only one remark to make, and that had reference to the waste of water: he quite agreed with the remarks of Mr. Cole, that the waste water which was allowed to run down the town drains was absolutely useless for any purpose of flushing. There was a common notion among most people that to allow their tap-water to run away, flushed the drains and did good service. It was perfectly valueless in that sense. With regard to the suggestion to put water meters in every house, or every few houses, that was a question which required very great consideration. He felt sure that if meters were put in most of the houses of the poorer classes it would engender amongst them a feeling of economy, and they would use as little water as possible. He feared that would prove a very *unsanitary* regulation. It seemed to him that the waste of water could be more effectually checked by Mr. Deacon's plan in having waste-water district meters; by which means the inspectors could tell the exact amount of water which has been wasted within a given time, and the consequence they could make inquiries as to how the water was wasted. The waste of water had been checked in Liverpool to a great extent by that system. He quite agreed with what Mr. Cole said about the sewage matter. He was surprised to find that in a city like Hereford, surrounded by a wide agricultural district, they had not yet found some means of utilizing the sewage. In towns which were surrounded by dense populations it was not surprising that they did not turn the sewage to good account, because there was no land. But that could not be said of Hereford, where land could be purchased at a low price. He hoped it would not be long before the city authorities made some better use of the sewage than at present.

The HON. SECRETARY said he had but few remarks to make, and he would begin by saying that the paper prepared by Mr. Cole was of the greatest possible interest to sanitary engineers. The

most important part of that paper was that referring to the water supply. Mr. Lobley had justly referred to the fact that it was surprising that in a city like Hereford, surrounded by agricultural land, they had not yet disposed of their sewage in some better way than by pouring it into the Wye. There was one point he would just refer to, and it was dealt with in Mr. Comber's paper also, and that was the ventilation of sewers. He was pleased to find from Mr. Comber's paper that the sewers of the town of Kidderminster and also that the sewers of Hereford were ventilated in the proper manner—by open gratings in the streets. But the water supply was the subject he wished to draw attention to. Mr. Cole was not alone in his difficulty in dealing with the waste of water. He (the speaker) had also considerable experience on that question, having just completed a difficult scheme for the supply of water to the town of Warwick. By calculation it was believed that 240,000 gallons per day would have been ample, but they found that 500,000 gallons per day were not sufficient; so that the matter of waste of water had seriously occupied his attention. There were various ways of checking that waste. Mr. Cole believed in the meter system, and to a certain extent he agreed with him, but that system must not be carried out in such a manner as to impoverish or interfere in any way with the poorer classes so as to prevent their having a proper supply of water. He thought that in many cases leakage would be found arising from the mains themselves in a very great measure; for he found in the town of Warwick that many of the mains were defective, and when they had been down for a number of years that was the natural result. Mr. Lobley referred to the scheme of Mr. Deacon, of Liverpool, as the most perfect system for checking the waste: that no doubt was a capital method.

He would like to direct the attention of the members to the quantity of water used in different towns per head, because it varied so much. In Glasgow it was 50 gallons per head; Dublin, 42; Bradford, 33; Liverpool, 27; Bath, 19; Huddersfield, 10. At Greenock the return was given at 72, while at Paisley it was only 9·6. He believed that proper supervision, with the introduction of Mr. Deacon's scheme by night inspection—for it was during the night that the greatest waste was registered—was the only means of preventing such a great waste of water. Taking the water generally at the low rate of 6d. per 1000 gallons, a great waste of water in a large town would mean a

great loss to the ratepayers—quite a large revenue—in many instances thousands of pounds per annum.

Mr. Councillor H. Dixon said, with the permission of the President he would like to say a few words upon the subject before them. He was very much interested in what Mr. Cole said about the ventilation of the drains at Hereford. Since they had laid their new drainage at Kidderminster that had been the most difficult question the authorities had had to deal with, on account of the enormous prejudices which existed amongst the people. The people had gone about putting their noses over the openings, and if they could detect the slightest smell, there were a host of complaints sent to the chairman of the public works or the inspector; the people had an idea that the slightest smell from those drains was doing the greatest amount of injury, and if there was a slight increase of disease it was at once attributed to the ventilation of the drains. The other members of the Council would bear him out that they had had great difficulty in preventing people from stopping up the openings. They would even stuff stones in the gratings, and the Council had laboured hard to convince the people that they were acting detrimental to their own interests in doing so. So far as he was concerned, he had strongly advocated that they should double the number of ventilators and untrap all the gullies. He believed that the great thing to obtain was free ventilation, they would not have half the smells if the drains were thoroughly well ventilated. No doubt it was a difficult question to convince people; it had been so in their own town. People had poured cabbage-water down the drains, and then ran to the pipes to see whether there was any smell, and then complained to the sanitary inspector.

The PRESIDENT said, the town he represented was another case in point. When he went to Southampton first there was an epidemic in the town. The health of the town was at a very low state; the inhabitants had stopped up all the ventilators, and yet there were tremendous smells. There was a thorough want of ventilation. He had great difficulty in getting rid of the prejudice of the people. He wrote an elaborate report on the subject, and submitted it to his Board. They thoroughly agreed with it, but they did not carry it out. When he was examined at Leeds, he told the chairman, in reply to the question as to the ventilation of sewers, that he put open gratings as freely as possible. He said they had better have smells in the street than in the houses. He

believed that at Leeds 14,000 ventilators had been put in, and he had not heard of any complaints having been made. He preferred the sewers being ventilated in the centre of the streets, because if not, the smells arose close to the footpaths, but if the ventilators were in the centre of the streets it was farther removed. There was this objection to the untrapping of the gullies, that during heavy rainfalls they could not get any ventilation of the sewers just at the time when that ventilation was most required. He was a strong advocate of ventilating the sewers in the centre of the streets. A long discussion took place at Birmingham upon that subject, and it was the almost unanimous opinion of those present that open gratings were the best, and that charcoal traps were things of the past. With regard to the waste of water, that was one of the greatest difficulties they had to contend with. In his borough the waste of water had increased enormously, and the authorities had been compelled to enlarge the mains. They would have done better had they provided means for detecting the waste. There were many ways of detecting the waste, but he knew none better than the system which had been devised by Mr. Deacon, of Liverpool. Inspection of waste water should be done in the night time and not in the day, because it was during the night that the waste really took place. Between eleven o'clock at night and five o'clock in the morning there was an enormous amount of water consumed, and it must be only by waste. In his borough they had a large reserve sewage reservoir, into which he turned the sewage at night, and by that means he was enabled to see the large amount of water that ran into the sewers during the night time. Local governing bodies ought not to neglect that important question of reducing the waste water. The commercial value of sewage had certainly been largely over-estimated. There was a time when sanitary engineers looked forward to making large sums of money out of sewage, but that idea was now exploded. It was a thing to get rid of, and at the least possible expense. Some years ago he published a report showing that large sums could be made out of sewage, but he had since many times wished that he had never published the report. They were led away by the results published about Croydon and elsewhere. If they could make a sewage farm pay expenses, they were doing a great deal; and if they could carry it on even at a small loss, there was no room for complaint.

In reply to Mr. H. Herring (Clerk of the Improvement Com-

mittee at Kidderminster), Mr. COLE said, at Hereford there were ventilators all about the town, from 50 to 100 yards apart.

Mr. COMBER asked Mr. Cole whether he had received any complaints of smells where the drain spouts were connected.

Mr. COLE replied in the negative.

The HON. SECRETARY said, it had been clearly proved that sewer gas was of greater density than common air, and the best way to dispose of it was as near the sewer as possible.

Mr. LOBLEY said, drain spouts for ventilation were universally admitted to be the wrong system.

Mr. DIXON asked if it was not a fact that the system of ventilation adopted at Bradford was to connect the sewers to the chimney shafts of the various manufactories. He had heard that system highly spoken of in the local papers. It would be possible to carry out that idea at Kidderminster if thought advisable.

The HON. SECRETARY said, even where it was possible to carry out that plan, he maintained that it was not desirable; but, generally speaking, it was impossible to do so, and certainly very impracticable. The proper system of ventilation, he was fully persuaded, was the one adopted in Kidderminster, and which was being adopted in nearly every town in the kingdom as local prejudices can be mastered, and that was open gratings, and to keep the sewers as clean as it was possible to make them.

Mr. DIXON said, none of the shafts would be at the dead ends in the town, but as nearly as possible in the centre.

Mr. COLE then replied to the criticisms upon his paper. Alluding to the observation that the waste of water frequently arose from the mains, he said, from experience he could say that at Hereford the mains had been down for twenty years, and for all practical purposes they were as perfect now as when they were first laid down. As to the drains, he was convinced that if there was plenty of air passing through them, there could be no complaints about sewage gas. He was decidedly of opinion that the waste of water would never be effectually cured until they had meters in houses very freely, the same as for the gas. They knew a few years ago there were the same objections raised against gas meters as had been raised against water meters, but he was not aware that the existence of those meters had prevented people from using as much gas, and so would it be with water. He would recommend that every consumer of water should be converted into a water-tap examiner. There was a greater waste among the gentry

than the poorer classes. They could not detect the waste either in the houses of the gentry, because their houses were practically closed to them, while the poorer houses were open at all times. He did not think that the general adoption of the water meters would have an unsanitary effect upon the poorer classes, because, generally speaking, it was the landlords who paid the water rent. At Hereford they had tried all manner of schemes, but they had not been successful, and he was persuaded that the only cure was the general adoption of the meter system. He was convinced of the necessity of something being done to teach people the real value of water, and nothing would be more effectual than meters in every house.

The Engineers, and the Chairman of the Drainage and Waterworks, and other members of the Kidderminster Town Council, then proceeded to visit the sewage works, irrigation farm, and waterworks, but time did not permit of them inspecting the carpet manufactories of Messrs. Morton and Sons, and Messrs. H. J. Dixon and Sons.

On their return to the Chess Room, Mr. COMBER, at the request of the President, re-read the principal portions of his paper, several members of the Association having arrived since the morning meeting.

Mr. COLE said he should like to ask how much the Kidderminster Corporation obtained for the sludge.

Mr. COMBER : We get about 20% per year.

Mr. LLOYD asked how far apart were the ventilating shafts in the town.

Mr. COMBER said the shafts were about 150 yards apart.

The PRESIDENT said, the tanks they had just seen were, he was going to say, an abomination. He saw no reason why the sewage should not be pumped up to the farm into the receiving tanks, and then they would be able to deal with it on the farm. He thought the tanks on the land ought to be duplicate or triplicate. He believed it was a mistake to have tanks only to one department; they could not clean them out without stopping the works. He thought the farm, as far as regards laying out, was open to considerable improvement, and it was only fair that they should speak honestly what they meant, and not try to make everything appear to be satisfactory when they knew that it was not so. If that farm had been done ten years ago, they might have expected to find

it as they had seen it that day, but they ought not to expect to see a newly formed farm laid out as that one was. The high level embankment was open to great objection. Covered drains might be made at various points which would enable them to plough the land all over. Mr. Crowther (the lessee of the farm) used open troughs on the land. He did not believe in them himself. They could work the land much better with covered drains; and it struck him that Mr. Crowther would find that the open troughs would not pay him, but that it would be to his advantage if he laid out a little money in what would be called permanent work, and have covered drains put down. Then as to the under draining, three feet deep did not seem to him to be sufficient.

Mr. COMBER said, it had been found that 3-foot drains were not sufficiently deep.

Mr. A. M. FOWLER said, it was necessary that the arrangements should give ample facilities for tanks to be cleaned out. At Edmonton there was a large reserve tank, into which was turned all the sewage of the town when the other tanks required to be cleaned out. The old idea of having sewage clarified to the greatest possible extent was now done away with. If they wanted to get rid of the surplus mud, they could send it on to the land and dig it in. It was absurd in his idea having those large covered sewage tanks; they were a complete waste of money. He had visited many places lately, because at Salford they were about erecting tanks, but he confessed he was disappointed with the tanks at Kidderminster. He should like to see a very great improvement in that direction.

The HON. SECRETARY said, if sewage was to be dealt with in a proper manner, it should be disposed of before decomposition set in. Sewage possessed its greatest value before the gases were rendered free, and it possessed the greatest manurial value before it became putrescent. His idea was that the sooner they could take the sewage from the sewer mouth on to the land the better for all purposes. Here was a strong fertilizer which the ground was prepared to receive and to abstract the objectionable constituents from it, and they thus prevented the possibility with a well-managed farm of a nuisance being caused. In Kidderminster the reverse appeared to be the case. A premium seemed to be offered for the greatest stink. They had the whole of the sewage pumped up, they allowed decomposition to set in before it was removed to the farm, when it had lost a considerable portion of its manurial

value, and became an intolerable nuisance on the spot. If illustrations were asked for where the system he had spoken of were referred to, many places could be mentioned, but he would content himself with two—Leamington, an aristocratic town, and the county town of Warwick. There were two farms connected with those places, a very short distance apart. The sewage from both towns was rich in organic matter, as they might naturally expect from a place like Leamington. The sewage was pumped from the sewer mouth, and in that state it was pumped on to the farm. There was no difficulty about it. There certainly were tanks to receive the night supply; and when it was found necessary to remove the slight deposit which accumulated, information was given to the people in charge of the farm that the solids were about to be sent up, and it was so arranged that what was then sent up was turned on to the fallow land and worked in. He did not altogether agree with that system, and explained the plan adopted in some sewage works in which he was at the present time engaged.

Mr. COMBER said, he did not agree with the use of troughs. He did not like the idea. Mr. Fowler was rather under a wrong impression with respect to the use of the covered tanks. They were not intended as precipitating tanks, but as collecting tanks to hold the night sewage, so as to avoid pumping at night. Some time ago he was directed to bring up a report in committee upon the sewage works, and he then advised the committee to dispense with the tanks altogether, and he was still of that opinion. Nearly all the matter which came down the sewers could be pumped to the farm while in a state of suspension.

Mr. FOWLER asked whether there were many water-closets in the town.

Mr. COMBER said, there were but few in the town at present.

The HON. SECRETARY: There is a large quantity of ammonia turned into the sewers in consequence of the manufactories.

In reply to a question, Mr. C. E. JEFFERIES (Clerk of Kidderminster Sanitary Committee) said, the removal of the night-soil paid itself, and the committee found it worked very well. It cost the Corporation from 150*l.* to 200*l.* per year to remove the night-soil, but the expenses were charged upon the tenants.

Mr. LOBLEY said, the expenses ought to be borne by a small rate.

In reply to a question, Mr. COMBER said, the water supply was constant in the town; but the whole of the houses had not yet taken the water; there were a large number of houses still dependent

upon the well system, but wells were constantly being condemned, and then water from the mains was laid on. The consumption in twenty-four hours was 250,000 gallons. He did not think it would be fair to take the 250,000 gallons as representing the average per head, because many did not use it.

- Mr. LOBLEY said, it was one of the strangest things he ever heard of to have the old midden system so extensively used where there were in the same town a good sewage farm and works. Kidderminster was certainly not keeping pace with the times. He should think that was the only instance where there was a sewage farm and yet an extensive use of the midden system.

Mr. FOWLER said, he should have preferred a discussion with reference to the water supply. He did not think that Kidderminster was so far behind in sanitary reform as they had discovered that day. It was a town where one-half the people were dependent upon wells, which in many instances were close to middens, for their supply of water, and yet where there was a good supply of water from the mains. In Cardiff, some years ago, the scarlet fever broke out, and a Government Inspector visited the place, and found that the whole town was on the cesspool system, to which the disease was attributed. Kidderminster would have something break out, and then the Government Inspector visiting the place would condemn the whole of the middens.

In reply to Mr. Lloyd, Mr. COMBER said, that no drains were allowed to be connected with the sewers unless either himself or some one deputed by him was present; and all drains were examined before covered up.

The PRESIDENT said they must now draw their meeting to a close; but they could not separate without tendering their thanks to the Mayor, Mr. Dixon, and other members of the Kidderminster Corporation, for the hospitable way in which they had been received that day. He was happy to state that in every town they had visited as yet, they had received a cordial welcome; but on that occasion they had received more than usual attention, and he thought they would be omitting a duty imposed upon them if they failed to recognise such kindness. He proposed that the thanks of the Association be given to the Mayor, Mr. Dixon, and other members of the Corporation, for the kindness shown towards the members of that Association.

The HON. SECRETARY seconded the motion, and fully endorsed what the President had said.

The motion having been unanimously carried, Mr. DIXON said he was sorry that the Mayor was not present to reply to the handsome way in which that Association had acknowledged the attention the members of the Corporation had shown towards them. He was expressing the views of the whole of the Corporation when he said that they were pleased the Association should have selected Kidderminster for their visit, not only from a desire to show their appreciation of the Association, but also that they might hear the views that had been expressed by gentlemen present. He was sure those words would not be lost upon the members of the Corporation. For himself, he felt pleasure in saying that he had learnt a good deal from the discussion to-day. Those meetings were of mutual benefit both to the members of the Association and also to those in authority where the members visited, for they obtained the advice of gentlemen of large experience in carrying on their work of sanitary reform. In a great many boroughs he knew, sanitary reform was at present in its infancy. He would only speak of their own borough. They had met with a great amount of prejudice and opposition in doing what they had done. They were conscious that their works were not perfect, but they hoped to make them so by-and-by. It was the desire and wish of the corporate body of that borough to put the town in a thorough sanitary state, both as regards its water and drainage works. He begged to say how cordially the Corporation of that town greeted them on this occasion.

The members and friends then adjourned to the Lion Hotel, where they partook of dinner, the Mayor of Kidderminster having consented to preside on the occasion.

DISTRICT MEETING AT PORTSMOUTH.

At a District Meeting of the Association at Portsmouth, March 1, 1877, the following paper was read :—

THE DRAINAGE OF THE BOROUGH OF PORTSMOUTH.

By LEWIS ANGELL, M. INST. C.E.,

PAST PRESIDENT OF THE ASSOCIATION OF MUNICIPAL AND
SANITARY ENGINEERS.

The ancient borough of Portsmouth possesses much national and historic interest as one of the principal naval and military stations of the empire.

The borough comprises four districts, viz., the old towns of Portsmouth and Portsea, each until recently enclosed by fortifications and offensive moats, and the two populous suburbs of Landport and Southsea. Previously to 1863 the borough was, for sanitary purposes, under the government of three distinct paving, lighting, and cleansing authorities, viz., the Portsmouth Commissioners, the Portsea Commissioners, and the Landport and Southsea Commissioners. For many years there had been an energetic and somewhat angry discussion as to the adoption of the then permissive Public Health Acts, and many were the battles fought both in and out of the Town Council over the matter.

In 1848 certain of the ratepayers petitioned the General Board of Health, an inquiry was held, and in 1850 Mr. Rawlinson, the superintending inspector, reported that the borough was unhealthy, the streets undrained and ill paved, the houses overcrowded, and that no adequate powers of effective local government existed. Mr. Rawlinson recommended the adoption of the Public Health Act, and a general system of drainage. An interval of thirteen years, however, elapsed without any improvement, and it was not until 1863 that the Public Health Acts were adopted by

the Corporation, and the three Boards of ~~Commissioners~~ swept away. The Town Council of the borough then became the sole Sanitary Authority, and some fourteen years ago the author of this paper was instructed to design a system of drainage for the entire borough.

In March, 1864, the author submitted to the Town Council, acting as the Sanitary Authority, a complete scheme of drainage, including an upper and lower level and a pumping-station. After much discussion the scheme was submitted to Sir John Hawkshaw, as consulting engineer, who endorsed the author's views, and reported favourably thereon. The scheme was also submitted to and approved by Her Majesty's Admiralty and War Departments, and finally, after elaboration to include the subsidiary sewers, it was submitted to the Secretary of State for the Home Department, who, on the advice of the Local Government Engineers, sanctioned the necessary loans. The author's scheme, having thus passed through four crucial inquiries without alteration, was adopted in its entirety by the Corporation, an Act was obtained, and in the spring of 1865, previously to the official ceremony by the Mayor, Mr. R. W. Ford, the author had the pleasure of turning the first sod of what was then one of the most extensive systems of drainage works out of London; and he has since had the satisfaction of seeing its successful completion, after many difficulties, under the very able supervision of Mr. Greator, the present Borough Engineer, to whom is also due the credit of designing some of the details, and extending the works, including a system of surface drainage for the low level district.

In an Association of Engineers, whose chief practice is in drainage, it is not necessary to describe details the nature of which must be familiar to all. The author, therefore, confines himself to a general description of the system involving principles of design, enlarging only on special features.

The borough of Portsmouth is situated on Portsea Island, about 13 miles in circumference, and contains about 9 square miles. Portsea Island is separated from the mainland on the north by the Portsbridge Canal, forming the moat of Hilsea lines uniting Portsmouth and Langston Harbours. The island is bounded by the Solent and Spithead on the south, on the east by Langston Harbour, and on the west by Portsmouth Harbour; each of which discharges its pent-up waters by the ebb-tide with a swift current.

The borough is situated on the tertiary formation. An alluvial

deposit of gravel and sand, interspersed with a clay locally known as "Stamshaw" clay, overlies the London clay. The gravel bed is from 12 to 20 feet thick, increasing towards the coast. During the progress of the drainage excavations the author observed several glacial boulders. The climate is mild and the atmosphere moist, south-westerly winds prevailing during two-thirds of the year. The mortality at present, and for several years past, has been remarkably low. Portsmouth generally stands at the head of the Registrar-General's list as showing the lowest death-rate of the large towns. The population is now about 113,000, but at the time of the General Board of Health Inquiry in 1850, when the population was only 55,000, the mortality was described as "excessive," viz. 25·37 per 1000, exclusive of cholera years. It is therefore obvious that the death-rate in Portsmouth has been greatly reduced during recent years.

Portsmouth is most unfavourably situated for the application of a natural system of drainage, no part of its extensive surface is much above and a portion of it is below the height of ordinary spring-tides; while such variations of altitude as exist impede rather than assist the engineer in the determination of the direction and gradients of his main lines of sewers. Scarcely anywhere is there to be found a favourable line of section. The highest, busiest, and most densely populated portion of the borough is elevated only about 12 feet above the tidal range, while about one-third of the borough is very little above the level of ordinary spring-tides and includes a large extent of marsh.

The most densely populated neighbourhoods were honeycombed with cesspools; in fact, Dr. Engledue, a local authority, had described the whole island of Portsea as "one huge cesspool;" while on the unpaved and unformed streets, which so largely abounded, the surface waters remained stagnant until evaporated or absorbed.

Before the Public Health Acts were adopted but little had been done to remedy the above condition of things, and that little without any directed effort to a permanent result. Indeed, in few boroughs could have been found a greater absence of those sanitary measures which an improved state of knowledge has shown to be necessary to life and health, and consequently to the general interests of the community. That the actual consequences to health were not very much more serious must be attributed to a naturally favourable soil and to the constant atmospheric circula-

tion maintained by the saline breezes and rapid tides which sweep round the island.

When the author first officially inspected the borough in 1863 he found it, as Mr. Rawlinson had reported 13 years previously, "low, flat and damp," the streets "ill-drained and unpaved," and the necessary works "difficult to execute." Looking back 14 years, a period comparatively early in the author's professional career, he well remembers the difficulties and anxieties of his task, which, since its completion, have been described in a local paper as "gigantic in extent and important in character."

The problem presented was the application of an efficient system of drainage, at a reasonable cost, to a district in which Nature gave so little assistance. The difficulties were so apparent as to have led to the popular supposition that the cost would be ruinous to the borough. The acknowledged difficulties and costliness of the undertaking had therefore induced much discussion and long delayed so necessary a work.

Another grave consideration was the disposal of the sewage. A great naval station, a garrison town, and a favourite seaside resort, were conditions demanding the most careful consideration.

To deal with the drainage first. The author considered it of great importance that the drainage of the more elevated districts should be so intercepted as to relieve the low-lying area from the upland waters and flooding during storms. The borough was therefore divided into two distinct drainage areas, an upper and a lower level, defined by the variations of altitude above the sea. The drainage of the higher levels of Portsea, Landport, and Upper Southsea, was intercepted and conveyed direct to the outfall, independently of the lower system. The low level district comprised Lower Southsea, Portsmouth, and part of Portsea, including the Dockyard and public establishments.

Having thus arranged the drainage areas, a more difficult question was the point of outfall.

No part of the sewage of the borough should be discharged into Portsmouth Harbour, and it was equally obvious that the sewage of 100,000 people, now increased to 113,000, should not be discharged into the clear waters of Southsea beach. However carefully and inoffensively the operation might be conducted, still sentiment, and the mere fact of its existence, would be most detrimental to the prosperity of the place.

Notwithstanding the great extent of coast bounding the borough,

the author was thus limited in the choice of outfall; the nearest point suggested was east of Lump's Fort; but buildings already extended to within less than a quarter of a mile of its western glaciis, and an examination of the coast showed that the line of shore from Southsea Castle to Fort Cumberland formed, with the West Winner sands projecting half a mile into the sea, an extensive bay of shallow and comparatively still water, out of the influence of the tidal current. The Admiralty chart shows a depth of only one fathom, at a distance of half a mile from the shore between Southsea Castle and Fort Cumberland; and the specific gravity of sewage being less than that of sea-water, it is more than probable that if the outfall had been placed at any point on this line of coast, the sewage would have floated on slack water and proved a most serious nuisance. Such being the case, the author directed his attention to the entrance of Langston Harbour, about four miles east of the entrance of Portsmouth Harbour, which offers the following advantages for an outfall:—

1. It is as far as possible from existing or any probable extension of the population.
2. It has a deep channel and rapid current which, during ebb-tide, conveys the sewage well out to sea.
3. It requires the main outfall sewers to intersect the island, thus providing for any future extension.
4. It is most favourably situated for the utilisation of the sewage.

The cost of the terminal outfall works would have been about the same at any point; but the advantages gained in carrying the outfall to the eastern boundary of the island far outweighed the additional expenditure involved. The entrance of Langston Harbour was therefore adopted by the author for the outfall of the entire borough drainage.

Having thus determined on a division of the borough into upper and lower drainage areas, and a distant point of outfall, the difficulty of arranging the gradients of very long lines over a very flat surface had to be encountered. The levels of a network of some 70 miles of sewers had to be worked out for intersection and convergence to a distant outfall.

The next question was, whether the scheme should be entirely one of gravitation by storing the sewage till low water, or should pumping be adopted? The author determined to keep the low level outfall sufficiently high to admit of its discharge by gravi-

tation at low water, and thus, by storage, be independent of pumping. The upper system could discharge continuously by gravitation, but it was not desirable that the sewage should be discharged into the ebb-tide so as to ascend the land-locked harbour of Langston, therefore the sewers were constructed with large storage capacity to act as reservoirs, so that the entire sewage might be impounded during the flood-tide. Hence at a convenient spot, about three-quarters of a mile from the outfall, the upper and lower level sewers unite at a pumping-station arranged for lifting the low level sewage ready for the ebb-tide, which would carry it far out to sea beyond the possibility of return. The scheme is therefore entirely gravitating, but supplemented by lifting power.

With regard to the general question of gradients there is much discussion. In the author's opinion and experience pumping should always, if possible, be avoided; it is better to have a flat gradient with a free outfall than a steeper gradient depending on pumps. Pumping is a constant expense; machinery fails at a critical moment or is unequal to the strain of an exceptional volume of drainage, whereas in a tideway a flatter gradient will always give relief twice daily for several hours together. Taking the balance of disadvantages, which is the province of the engineer to estimate, flat gradients, especially with a reserve of flushing power as at Portsmouth, is to be preferred to a dead end with outfall sumps dependent on pumps. Acting on this view, supported by Sir John Hawkshaw, the author constructed the lower end of the system with very flat gradients. The common outfall from the pumps to the shore, in front of Fort Cumberland, is an oval brick sewer, 5 feet by 3 feet 9 inches internal diameter, continued through the beach to low water by iron pipes secured by piles. The length from the pumps to low water is about 4630 feet, with a fall of 6 inches per mile. At the pumping-station the system divides into an upper and lower level sewer, each 4 feet in diameter, and as they traverse the same line they were constructed in the same trench for a length of about 2400 feet, the invert of the upper being built on the crown of the lower, and the whole surrounded with concrete. This length has a fall of less than 1 foot per mile. At the junction of Highland Road and Eastney Lane, about 800 yards from the pumping-station, the lower sewer diverges into Lumps Lane, with an increased gradient of 2 feet per mile, until it reaches Southsea Common, where the size is reduced from a 4 feet barrel to a 4 feet by 2 feet 8 inches oviform section, and

the gradient increased to 3 feet per mile, continuing through Portsmouth and into Portsea, where, for short lengths, gradients of 6, 8, and 26 feet per mile are obtained.

The upper level sewer, from the point where the lower diverges in Eastney Lane, is continued 4 feet in diameter, with a fall of 1 foot per mile for about 600 yards, as far as the cemetery, where the gradient is increased to 4 feet per mile, and subsequently to $7\frac{1}{2}$ feet per mile, with a 4 feet by 2 feet 8 inches oviform sewer, the remainder of the upper system, through Landport and Fratton to Kingston Cross, having fair falls.

The arterial system above described exceeds 11 miles in length, and cost 84,000*l*. Fifty-six miles of lateral drainage have been engrafted upon it under the direction of Mr. Greatorex, the Borough Engineer, at a cost exceeding 61,000*l*. The engines and buildings cost some 7650*l*., and the surface drainage 7000*l*., the total cost of the works being about 160,000*l*.

The system of ventilation adopted for the main sewers is by manhole shafts at frequent intervals along the line of sewer. Each manhole has a small side chamber, having a grating level with the road surface, and open to the external air; also a vertical opening into the manhole shaft, in which a charcoal-basket may be fixed. In the author's opinion, the intervention of charcoal or any other dense medium between the sewer and the outer air is, as much as possible, to be avoided. Charcoal, when dry, may and does absorb the impurities of foul air passing through the screen, but the practical effect is to cork up the sewer. The more freely air circulates into, through, and from the sewers, the less danger of the accumulation of the foul gases, which force their way into dwellings. In Leeds every street ventilator and gully, some 13,000 in number, has been untrapped, and, it is said by the authorities, very much to the advantage of the town. The author is informed that the medical officer of Portsmouth has directed the removal of the charcoal baskets. The house drains should also be well ventilated.

Provision is made for flushing the sewers in sections by oak sluices fixed in the ventilating shafts. The sluices fall into grooves, cut in Bramley Fall stone, built in the walls of the sewer, forming a dam by which a head of water is obtained for scouring the sewer on raising of the sluice. Should a greater flushing-power be required, it can be easily obtained by constructing tanks at any points near the sea, from which they may be filled at high water, and discharged through the sewers at low water. The author con-

templated using the Camber Corporation Dock for this purpose; a connection between it and the low level main in Portsmouth would afford frequent opportunities for a great power of flushing.

Great difficulties were encountered during the execution of the works. At the very commencement the navvies were driven away by a firing party from Fort Cumberland, because some technical point in the red tape arrangements between Her Majesty's various official departments had not been arranged among themselves, consequently the works had to be commenced at a point of great disadvantage to the contractor. Great difficulties were also encountered with the loose shingle of the beach and glacia of Fort Cumberland. Running sand and water was also a source of great trouble. Steam pumps had to be kept constantly going over the greater part of the works.

The sewers were constructed with local bricks built in Portland cement below the springing, and the upper half in lias mortar. The cement was tested to the standard of the Metropolitan Board of Works.

Two or three questions are suggested in the foregoing description. Ventilation and gradients have already been briefly discussed. With regard to a separate system of surface drainage for the low level district, having intercepted the higher level it was the author's intention to divert the lower level surface drainage as much as possible by overflows into the moats and into old channels of drainage. The necessary works of the original scheme were so expensive as to preclude at that time any consideration of accessory works. The author has applied the separate system to towns, such as Maidstone and West Ham, where the sewage has to be purified at the outfall; in such cases the reduction of the volume of sewage is a very important consideration. Such reasons did not, however, apply to Portsmouth, where it is simply a question of capacity of sewers and cost of pumping, but as the moats are no longer available for receiving the surface drainage, Mr. Greatorex, in the author's opinion, acted wisely in inducing the Corporation to construct such works, and thus reduce the volume to be pumped.

Upon the question of the utilisation of the sewage: with such an outfall as at Portsmouth, the author, although fully alive to the question, saw no necessity, inasmuch as with proper working no nuisance should arise. With regard to waste, doubtless sewage *per se* is a valuable manure, but, unlike other manures, it is not under control; it does not adapt its supply to the demand; there-

fore, excepting under the most favourable and exceptional circumstances, sewage must be financially a drug. Where purification is a necessity, land supplies the best means of both purification and utilisation, but the contingent difficulties and expenses of pumping, distribution, and under-drainage, are such that no undertaking has yet shown a financial success; therefore, apart from sanitary considerations, it is cheaper to waste than to utilise. Under these circumstances, it is probable that Portsmouth will continue to cast its sewage into the sea.

PORTSMOUTH DRAINAGE.

By J. E. GREATOREX, BOROUGH ENGINEER.

FOLLOWING the description by Mr. Angell of the general scheme of the drainage of the borough, it is proposed to take up the description of the subsidiary sewers, of which there are 56 miles. The brick sewers are constructed with Jennings' stoneware invert blocks, the cavities in which were filled with fine concrete, which gave a much firmer and better butt-joint, and retained thoroughly the cement with which they were jointed; the remaining portion was built with proper radiated bricks, set in Portland cement up to the springing, and the arch with similar bricks, jointed with Greaves' ground lias lime from Harbury, Warwickshire. They are oviform in section, and their sizes are 3 feet \times 2 feet, 2 feet 6 inches \times 1 foot 8 inches, 2 feet \times 1 foot 4 inches, and 1 foot 9 inches \times 1 foot 2 inches respectively, a small length (in consequence of difficulties arising with large gas and water mains) was constructed circular on section with similar material.

The remaining portion, comprising about one-half the total length, was laid with Jennings' stoneware pipes, 15-inch and 12-inch diameter, nothing less than the latter size being used for a sewer. The 15-inch pipes were $1\frac{1}{4}$ inch thick, the 12-inch $1\frac{1}{8}$ in., and in both instances the sockets were $2\frac{1}{2}$ inches deep; they were in all cases bedded on, and surrounded by, fine lias lime concrete, not less than 4 inches in thickness, and on bog land, of which there is a considerable quantity special construction was resorted to by making the trench 12 inches deeper than required for the sewer, laying concrete therein, then three longitudinal timbers, 4 inches \times 4 inches, creosoted, on cross bearers, every 4 feet fixed diagonally, after which the interstices were filled in, and the bed made up to the proper level with concrete; and this mode of construction, under most difficult circumstances, has answered exceedingly well.

Proper eyes, with disc in the socket for house-drainage, were inserted along the lines of route, and the position of each marked

where practicable, with broad arrow, at a right angle on the wall of houses opposite the insertion; by this means they are easily found when required, for the purpose of carrying out the house drainage. All the sewers and eyes were also accurately plotted on the Ordnance map, on a scale of $\frac{1}{800}$ or 10·56 feet per mile, which shows their positions very accurately and distinctly.

As necessitated by the extreme flatness of the surface of the district, there being a difference of level of only 20 feet in 4 miles, the subsidiary sewers have poor gradients. The inclinations ranging from 1 in 650 to 1 in 100, the ruling gradient being about 1 in 320, they require constant attention by flushing, which is sufficient for the purpose of keeping them clean, and in good working order. For this purpose flushing and inspection shafts are constructed at every extreme or dead end, and also at intervals of about every 100 yards. The average cost of flushing and cleansing the sewers, including the mains, is 153*l.* per annum.

All the sewers are ventilated as follows, viz., a brick chamber is constructed by the side of the flushing and inspection shafts, an opening 18 inches square being formed between the two. In this opening a galvanized iron basket or tray filled with charcoal was fixed. The charcoal has been changed about three times a year, on an average, in dry situations, and with small flow of sewage it would last longer, but in situations where breweries or steam engines discharged into the sewers, it requires to be renewed more frequently. At the recommendation of the medical officer of health the charcoal is now being abandoned.

As previously described the low level sewer is carried on to the pumping station at Eastney, a point about 3 miles from the centre of the district, by which the high level sewer passes also. The former is here conducted through a chamber, fitted with intercepting grates to a sump, and is lifted from 12 to 18 feet, varying with the rise of tide, by a pair of 25 horse-power rotative condensing beam engines, and discharged into the high level sewer, which is here enlarged to receive it. The pumps are on the bucket and plunger principle and are capable of lifting 1100 cubic feet of sewage per minute. The average annual working expenses for wages of engineman, stoker, men at intercepting grates, coals, oil, tallow, &c., are about 680*l.* They, however, vary directly in the ratio of the dryness or wetness of the seasons.

It has been the great object, in carrying out the sewerage, to keep as far as possible all rain-water out of the sewers, more par-

ticularly from the low level, on account of its requiring pumping. And for that purpose a special system of drainage has been constructed to convey the rain-water from the western portion of the district into the harbour. The cost of the main and subsidiary sewers, pumping engines, buildings, and land, was 153,000*l.*, and of the storm drainage, 7000*l.*

DISTRICT MEETING AT SHEFFIELD.

A MEETING of the Members of the Yorkshire District of the Association of Municipal Surveyors was held at Sheffield, on Saturday, the 29th September, 1877. The Members assembled at the Victoria Station Hotel, where they were met by Mr. Coghlan, the Borough Surveyor of Sheffield. They subsequently, under his direction, visited the Cyclops Works, the well-known establishment of Messrs. Charles Cammell and Co., Limited, and were shown through the several departments. Mr. Coghlan next took the Members to inspect the line of tramways now being constructed from Sheffield to Nether Edge.

On their return to the town, a meeting was held in the Mayor's parlour. It was presided over by Mr. Ashmead, M. Inst. C.E., Bristol, the President of the Association; and there were present,—Mr. Cross, Dewsbury, Honorary Secretary, Yorkshire District; Mr. Deacon, M. Inst. C.E., Liverpool; Mr. Morant, A. Inst. C.E., Leeds; Mr. Pagan, A. Inst. C.E., Wakefield; Mr. Smethurst, Sowerby Bridge; Mr. Hildred, Batley; Mr. Harry, Harrogate; Mr. Allisson, Bradford; Mr. Coghlan, Sheffield; Mr. Cole, Hereford; Mr. Biddle, Bootle; Mr. Escott, Halifax; Mr. Jennings, Rotherham; Mr. Scriven, Pontefract; and Mr. Stovin, Sheffield.

Mr. Cross, Honorary Secretary, read the Minutes of the last meeting, which were then unanimously confirmed.

On the motion of Mr. SMETHURST (Sowerby Bridge), seconded by Mr. MORANT (Leeds), it was resolved that the next Meeting should take place at Bradford, and that it should be held as early in January as possible.

Mr. Cross mentioned the names of several Members who had sent letters regretting their inability to attend, and expressing a hope that the Meeting would be a successful one. He also said he had received a few letters from Members at a distance, who were unable to attend the Meetings, and who considered it was little use to them to belong to the Association, inasmuch as they were not furnished with a copy of the Proceedings. Living so far away from the centre, they considered the least the Association could do was to send them an account of the Meetings which they could

not attend. On this subject the President had some remarks to make.

The PRESIDENT said he much regretted that the volume of the Proceedings had not yet been sent out, but the matter was beyond their control. The work was undertaken by Mr. Angell, who had edited the first two volumes of the Proceedings, and in whose possession the papers for the third volume now were. Mr. Angell had written a letter, stating that he had been so much engaged that he could not complete the volume sooner, and that he hoped to have it ready in a short time. He (the President) hoped it would be in the hands of the Members in the course of three or four weeks. The succeeding volume was in an equal state of forwardness, so that they might expect to have both volumes shortly. As regards the future, there was reason to hope they would have the Proceedings much more regularly. It had been arranged that each District Secretary shall have Minutes of the District Meetings printed and circulated to the Members within twenty-eight days of each Meeting. The Minutes would of course be forwarded to the General Secretary and embodied in the Proceedings.

In answer to a Member,

The PRESIDENT said he had requested Mr. Angell to employ a sub-editor to assist him in getting out the volumes, and he believed Mr. Angell had done so.

A brief discussion ensued, in the course of which the opinion was generally expressed that it was most desirable the Proceedings should be sent to the Members without unnecessary delay; and in the end the Secretary of the District (Mr. Cross) received instructions "to write to the General Secretary asking him to urge on the Council the desirability of employing a paid editor for future Proceedings, so that the Members can have a copy as soon as possible."

ON THE SINKING OF CYLINDERS FOR BRIDGE PIERS AT SOWERBY BRIDGE.

By MR. J. H. SMETHURST, SOWERBY BRIDGE.

IN submitting the following paper, I do so in the hope that it will be not only of some interest, but also of some use to the Members of the Association. I believe that it is only by communicating to one another the particulars of works executed that the greatest object of the Association can be fulfilled.

I do not propose to advance any new theory, but simply to explain briefly one or two methods of sinking cylinders for bridge construction, including the method adopted by me at Sowerby Bridge.

I shall confine myself to the pneumatic method of sinking cylinders.

The original manner was by the use of atmospheric pressure on the outside of a hollow cylinder, in which a vacuum was created by the air-pump; as the air was withdrawn from within the cylinder, the atmospheric air forced up the soil upon which the cylinder rested with the water into the inside of the cylinder, so that it sank by its own weight until it reached a firm stratum, or became so deeply inserted in the river bed as to offer, by the friction of its sides against the soil, sufficient resistance to the vertical load of the superstructure.

This method has been tried at several places, but not in all cases with success; where any obstruction occurs that cannot be removed by dredging this method is certainly not desirable; besides which it is not only more expensive, but less advantageous than the more simple method of sinking the cylinders by weighting them.

The improvement upon this method, and the one which I adopted at Sowerby Bridge, is as follows, namely, instead of exhausting the air from the cylinders to compress the air within them, which, being closed at the top and open at the bottom, causes all fluid matter to be driven from the interior; this not only allows men to work inside and to excavate the soil, but has an invigorating effect upon them.

I found that the dense air infuses them with more energy, and that they can do more work than they could under similar circumstances above ground at the ordinary atmospheric pressure.

In 1874 I was instructed by the Sowerby Bridge Local Board to prepare plans, &c., for the widening of the county bridge, crossing the river Calder, at Sowerby Bridge. This bridge is the only means of access from the south portion to the northern portion of the town, and was only 18 feet in width, consequently the traffic over it was often greatly impeded.

Three designs were submitted by me to the Board for their approval, the result being that the design now before you was adopted.

Borings were made on the site of the piers, and a considerable difference in the solid stratum was found; in one boring rock was found at a depth of 17 feet below the bed of the river, and in the other boring it was reported to be only 9 feet deep; but this last was subsequently proved to be incorrect, as on executing the works it was found that a large boulder had intervened which had been taken for the solid rock.

The first method that was tried for sinking these cylinders was, after they were lowered on to the river bed, by using a hand pump to extract the water within them, so that a man could get inside and excavate the soil; this was found thoroughly impracticable. After this a centrifugal pump, worked by a portable steam engine, was tried to keep down the water, but this also failed, as the bed of the river was so porous.

Finding these methods to fail, I decided on adopting the pneumatic method.

The cylinders are of cast-iron, 3 feet 6 inches diameter, and $1\frac{1}{4}$ inch thick, cast in lengths of 5 feet, and fastened by the means of flanges on the inside.

In commencing the operation, four cylinders were fastened together and placed in position in the river.

The air was compressed with a small horizontal engine, which was worked with a portable engine, and was connected to the cylinder with an ordinary leather hose pipe. The top cylinder was used as an air lock, by which means the workmen were enabled to descend and excavate the soil, and into this cylinder all the excavated material was drawn up previous to being passed outside.

The air lock was formed by placing two cast-iron covers, with

circular man-holes, 18 inches diameter, as shown on the accompanying detail drawings, and the man-hole openings were provided with cast-iron doors, opening downwards, the faces of which were planed and covered with india-rubber rings.

The air lock was worked by the taps A and B.

Supposing the air to be compressed in the bottom chamber, the workmen, on entering the top chamber, closed the top manhole and the tap A, then opened the tap B, when as soon as the air was compressed in the air lock, the bottom man-hole door opened.

Each cylinder was sunk to a depth of 17 feet below the ordinary level of the river, in four days, and was subsequently bedded firmly on the rock.

An attempt was made, before detaching the air compressor, to fill the cylinders with concrete, but without success, as the pressure of air carried away the lias lime and left only the clean ballast.

By stopping the air compressor, and then allowing the water to rise in the cylinder, they were filled with concrete to the height of 3 feet, by using a box with a loose bottom, into which the concrete was placed after being mixed; and when lowered to the bottom the concrete was emptied by opening the bottom of the box with a string attached to a catch.

After allowing the concrete to set for six days, the water was pumped out of the cylinder, and it was found to be perfectly water-tight; the cylinders were filled with concrete in 12-inch layers.

It is now over two years since the cylinders were sunk, and no perceptible settlement has taken place.

The total cost of each pier, complete, was 90*l.*, the cost of the ironwork alone being 57*l.*

It was originally intended to put down stone piers, and tenders were received from several contractors, the lowest being 250*l.*

The Board, by adopting the cylinders, saved the sum of 160*l.* in each pier, besides in no considerable way obstructing the waterway of the river.

DISCUSSION.

The PRESIDENT, in inviting discussion on the paper, said it was a very interesting one, and just the kind it was desirable to have at such meetings as the present. If Members of the Association would make notes of the works executed by them, and then furnish the particulars to the Association, mutual advantage could not fail to result.

Mr. CROSS (Dewsbury) said he should like to ask one or two questions. Mr. Smethurst had not told them—what was a very important point—how the air was compressed. He simply said he used a horizontal engine worked by a portable engine. It would be interesting to know how the horizontal engine was made to act as an air compressor. Another thing upon which he (Mr. Cross) should like to obtain information was as to the bridge belonging to the county, because it was very strange that a local body should widen a county bridge. Mr. Smethurst also said he first tried a hand pump, and then resorted to a centrifugal pump, as the former was not equal to the work. He should like to know whether it was Mr. Smethurst's idea or whether it was the idea of someone else, that a hand pump was going to keep the water down in such a porous soil as that at Sowerby Bridge.

Mr. MORANT (Leeds) said the members were no doubt aware that the same plan of sinking cylinders had been adopted at other places—at Rochester, for instance, where a bridge had been built over the Medway. That was something like fifteen or eighteen years ago; and he believed the same plan was adopted in France long before.

The PRESIDENT asked whether the cylinders were sunk in sections?

Mr. SMETHURST: Not in any case. We bolted all the cylinders together before we commenced.

Mr. MORANT remarked that a bridge had been made over the Thames, in which case just the reverse system was adopted—the air having been exhausted and the cylinder falling by its own weight. In the case of the Rochester bridge, the cylinders were weighted as well, so as to press them down. Did Mr. Smethurst have any weight?

Mr. SMETHURST: None.

Mr. MORANT: They had in that case, I know. There they had many tons, so as to press the cylinders down as soon as they had loosened the soil.

Mr. SMETHURST: In our case, as soon as we let out the compressed air, the cylinders would drop about 18 inches all at once.

Mr. MORANT: And they held it by the side pressure. At Rochester—supposing this to be the cylinder—they worked evenly round it, and as they gained an inch, that inch went down in the cylinder. When they had sunk the cylinders and the men were at work, they took up the top cage with this intermediate door and took them on to the next door.

Mr. SMETHURST said that course could not have been resorted to at Sowerby Bridge, inasmuch as there were a good many old piles in the river.

Mr. MORANT added that when the water was forced out the men worked dry, and as they gained on the ground from the cylinder, then the cylinder fell. That was the principle of it.

The PRESIDENT (to Mr. Smethurst): You don't say when you came to the rock whether you made a level bed?

Mr. SMETHURST: It was dressed off.

Mr. ALLISSON (Bradford): At the side? He also wanted to know whether the cylinders were closed on the top. The compressed air was put into the cylinders, and the force of it would push out the *débris* inside, so that he understood there were no men employed inside at all.

The PRESIDENT: That could not be.

Mr. ALLISSON: I understood Mr. Smethurst to say so.

The PRESIDENT said he understood the same thing at the first, but as the paper went on, he saw that that impression was incorrect.

Mr. MORANT said it was only a question of a cofferdam. The water was forced out, or probably was forced out by a pipe turned up over the water.

Mr. SMETHURST: Oh, no; all we had is shown on the plan.

Mr. MORANT: Then how did you get rid of the water? Where does the water go?

Mr. SMETHURST: It is forced out at the bottom of the cylinder.

The PRESIDENT: And the compressed air prevents the water from rising?

Mr. SMETHURST: It forces it entirely out.

Mr. MORANT: Then it is so loosely laid. But in a case I have known, a pipe led from the bottom over the water, so that when the air has been pressed in, the water has been driven out by means of this pipe and so out of the level. That would be necessary if you got the cylinder securely fastened in the soil, as there would then be no exit for the water.

Mr. SMETHURST: There would be no necessity for the pneumatic principle at all if the cylinder was altogether out at the bottom.

Mr. MORANT: No, not if it was. It is a very good system, no doubt. In many cases nothing else will answer. What power was the engine you had?

Mr. SMETHURST: I do not know, I am sure.

Mr. DEACON (Liverpool): You had not any arrangements for guiding the piers?

Mr. SMETHURST: No, we did not find it necessary at all.

Mr. MORANT: They went down straight?

Mr. SMETHURST replied that that was so, and that after preparing for the cylinders being placed into the ground, his experience was that they went into the positions intended for them within half-an-inch.

Mr. DEACON said as they were so light the mere friction against the sides would keep them up. That, however, was not usually the case, and especially when the cylinders were larger. Where the same principle was resorted to, the usual tendency was to go down much more on one side than the other, and to sink while the process is going on.

Mr. MORANT: I don't quite understand one thing you said. You remarked that you could not get the concrete to set. How was that? You said, if I did not misunderstand you, that at first you made an attempt to fill the cylinders with concrete, but that you could not do so in consequence of the compressed air forcing the lime away from the stone, or something of the kind. I don't understand how that should be. Am I right in so understanding?

Mr. SMETHURST: Yes.

Mr. BIDDLE (Bootle) wanted to know at what pressure Mr. Smethurst worked, and what pressure the men were able to stand whilst working inside the cylinders. He also wanted to know whether he erected them in one length or in sections; whether the men were working in the dry; whether he got down to a rock foundation, and if so, what depth he excavated. They were aware that the rivers in such a district as that at Sowerby Bridge had a

very rapid current, that at times there were very heavy floods, and that sometimes the rivers rose from 10 to 15 feet. He should like to know in what way Mr. Smethurst went into that question. If he understood him aright, he got down to a rock foundation, and then placed the blocks with the concrete and allowed them to stay and the water to rise inside the cylinders. Then he understood him to say he pumped the water out of the cylinders, and buried the concrete in 12-inch layers. There was no provision for any flange at the bottom of the pillar, and he supposed the whole of the superstructure rested upon the cylinders. It was simply several cylinders dropped into the ground, the superstructure rested upon them. He saw that a portable engine was used. He supposed Mr. Smethurst had some contrivance for working the compressed air into the cylinder.

Mr. ALLISSON said the drawing showed as if the sides stood, as if it were an excavation in hard rock, and that the excavation stood without falling. But surely it was hard up against the cylinder all the way down, was it not?

Mr. SMETHURST: We never did ascertain that.

Mr. ALLISSON: What sort of stuff did you take away?

Mr. SMETHURST replied that there was a boulders deposit in the river—something like 11 feet of it.

Mr. BIDDLE: How did the men work underneath? Had they any light? If so, in what way—oil lamps or candles? I should think myself that gas might be made use of with advantage. It seems to me that for men to be locked up in the cylinder, in total darkness and under pressure, is a miserable state of things.

Mr. ALLISSON said it would be useful if Mr. Smethurst would state what distance he carried the concrete from the top—what was the depth of the concrete put in. If solid—and he supposed it would be solid—what was it—lias lime, cement, or something else?

Mr. BIDDLE: And will you say what depth of water there was while you were doing this work—the average depth, I mean?

Mr. SMETHURST, replying to the discussion, said: At the outset our arrangements were of a primitive character altogether. I prepared the plans for the widening of the bridge, and designed it as you see there; but owing to the great amount of work I had in hand at the time, the Board thought I could not attend to the matter, and so they put the work into the hands of a local contractor. He got

these cylinders done by daywork, and, first of all, he used the hand pump, to which I referred in my paper. That did not answer, and then he tried a centrifugal pump. I told him before, indeed even from the very first commencement, that the thing would not do, and that he would never get them down in that manner. They went on at that rate for about three weeks, when the contractor reported that he had got one of the cylinders down 6 inches. Subsequently he allowed me to put the air compressor at work. That is how the hand and the centrifugal pumps came to be used. Then as to the bridge belonging to the county. At the time it was widened, or some little time before, our Board asked the Local Government Board for power to borrow money to widen it. An inspector was sent down to our place to see about it, and he said that the Board could not legally borrow money to widen a county bridge, that we had nothing to do with it, and that it was the county that ought to widen it. He reported to the Local Government Board to that effect, and consequently we could not borrow the money. But our Board took the cost out of the gas profits. They thought, I suppose, that that was the best way of doing it, and they were determined the bridge should be widened. The cost, I suppose, was about 3000*l.* altogether; and before they would be beaten, they took it out of the gas profits. The profits were to be applied to sanitary work, and they considered this was sanitary work. Then with regard to the depth of water. The piers were sunk 11 feet below the river bed. Six feet of water was the ordinary summer level—that is taken as the mean level. We had something like 6 feet of water and 11 feet of stratum to go through. So far as regards the centrifugal pump, that was not my idea at all—far from it. With regard to the rock, when we got down to it, we went through it about 18 inches. We found it dipped to the south a little, and we so worked on it as to make a perfectly level bed, for the cylinder to rest upon. The compressed air did not force out the soil at all. It forced out the water, leaving the cylinder comparatively dry, so that men could work at the bottom as dry as we are here.

The PRESIDENT: And the men were able to work in the compressed air?

Mr. SMETHURST: When anyone first entered the cylinder there was a sensation of pricking underneath the ears. But that passed off in about half a minute—it lasted but for a few moments. That

was all. We used no stage whatever for supporting the cylinders. We got them down in the exact position we wanted them—in fact, where they were put into the river at first.

A MEMBER: What was the pressure?

Mr. SMETHURST: Our pressure was regulated according to the depth of water. The highest pressure was 8 lbs. to the square inch. Then as to the concrete. The reason we could not get the concrete to stand was because the compressed air blew all the lias lime into the river. I do not know why, but it did so. The concrete went down to the bottom, but the air blew out all the lias lime—in fact, anything that was used.

Mr. MORANT: You put it in too wet, perhaps.

Mr. SMETHURST: Perhaps that was it; but it was mixed up in the ordinary way.

A MEMBER: What did you say was the pressure?

Mr. SMETHURST: The highest pressure we had was about 8 lbs. The cylinders were as you see them here. These were put together first. Then the flange put here and with an 8-inch cylinder man-hole. Then another flange on the top with another man-hole here also. By opening these taps, you could get down to the bottom of the cylinder. There is no flange shown on the drawing, in fact it was never intended for them. I thought when I designed the work, I might have got them down by weighting them; but, however, that could not be done; it was simply impossible. So far as regards the men working in the cylinders, candles, oil lamps, indeed anything you liked, burnt as freely there as they would in this room. There was no difficulty about that. I may say the first time I went down I had a score of candles burning, they quite illuminated the place. After we got the cylinders down to about this level here, they were filled up to the top. The ironwork, the girder that spans the bridge, rests upon a stone two feet deep. There is no weight at all upon the iron; that is protected. It is simply a lateral pressure. With regard to the concrete, it was at the rate of four to one of lias lime in this case. When I took to the whole of the work, the contractor had a portable engine on the place, and consequently I had to employ it. Then I had some difficulty in getting an air compressor for the work; indeed I did not know where I could go to get one. I kept on inquiring for about a week, and at last I resolved to manage by the ordinary steam engine. I compressed the air by means of a small horizontal engine, rotated in the contrary direction

by means of a leather belt from the portable engine. In the first instance, I had the slide valve made to cut off $\frac{1}{8}$ inch shorter than ordinary, and when the piston was working, raw castor oil was poured into the cylinder, down the inlet pipe, from time to time. The steam chest was immersed in water, in order to keep it cool, and also to cool the compressed air passing through it.

Mr. MORANT: What kind of packing had you on the piston?

Mr. SMETHURST replied that he did not know. He used the engine just as it came from the makers, whose names he mentioned. The effect of pouring in the oil, as he had described, was to make the cylinder perfectly tight. There was no loss of air.

Mr. MORANT: What was the diameter?

Mr. SMETHURST: For compressing air—9 inches.

The PRESIDENT: What means had you for testing the pressure inside the cylinder?

Mr. SMETHURST: I had a safety valve put in at that point, and there I had a pressure gauge put in.

Mr. ALLISSON said Mr. Smethurst had explained that he had the rocks for the foundation chipped until he got them level; but he had not explained what means he used to keep the cylinders perpendicular at the time that work was going on. It was evident that the cylinders must have been resting on a hard surface on the one side and upon soft material on the other. With cylinders of this weight, resting say upon 16 inches of hard surface on the one side and on 18 inches of soft material on the other, it was evident that they would get out of perpendicular. Then the flanges seemed to project inside. If that was the case, as soon as they got above the first flange, that was from the bottom, the whole weight of the concrete would rest upon the flanges. Then he saw by the drawing that a hand bucket was used for taking the material from the inside. How was it that a winch or something of that kind was not employed?

Mr. SMETHURST: So far as regards the cylinders weighing on one side, there was nothing of that kind. I have known them several times to be suspended—from the air being forced inside—I have known them to be suspended a clear 18 inches; and as soon as ever we allowed the compressed air to escape, the cylinders would drop instantly.

The PRESIDENT: You must have had guide ropes, or something of that sort?

Mr. SMETHURST: No, there were no guide ropes. There was a

slight staging round, but it was not put down with the view of supporting the cylinders at all.

The PRESIDENT: It is a most extraordinary circumstance that they did not go over.

Mr. SMETHURST: As regards the concrete, it is an idea of my own, that there is no greater pressure on the cylinders with the flanges being inside.

Mr. ALLISSON: I may be wrong, but I think from the rings of the cylinders projecting on the inside, the rings would take the weight of the concrete.

The PRESIDENT: I think there is no doubt about that.

Mr. MORANT: It is one mass.

Mr. ALLISSON remarked, that if the rings had been on the outside the cylinders would not have borne the weight. The concrete would then have stood on its own weight.

Mr. SMETHURST said, As regards using a winch, there was no room for one, as there was only 5 feet of space for a man to work in.

Mr. ALLISSON remarked, that a scaffold might have been put down outside.

The PRESIDENT: The only objection to the use of a hand bucket is the time and expense.

Mr. DEACON asked, what was the weight of the cylinders?

Mr. SMETHURST: The metal is $1\frac{1}{2}$ inch thick, and 3 feet 6 inches diameter. They were cast in 5-foot lengths, and the total length is about 27 feet.

Mr. BIDDLE asked, what was the diameter of the air-pipe?

Mr. SMETHURST replied, that it was $2\frac{1}{2}$ inches, and was of leather.

The PRESIDENT: And that stood the 8 lbs. pressure?

Mr. SMETHURST replied, that there was some slight loss of air on its way from the engine to the cylinder.

Mr. DEACON (who had been working out a calculation): The weight of the cylinders, as nearly as possible, is 6 tons. The upward pressure of the air is just 5 tons, so there is 1 ton to be accounted for by friction—that is to say, that the friction suspended 1 ton. You see that the thing is not so large as we have been imagining, and you can readily understand that they would stick up until the air was let loose. There is nothing very astonishing after all. You say they would drop 18 inches when you let the air go?

Mr. SMETHURST: We took care to chip the rock whilst they

were suspended, and then let them go. Then they would drop whatever distance they were suspended.

Mr. DEACON: I have paid some attention to the matter of making concrete, and I have found great advantage from making it so dry that when you squeeze it in the hand, you only just see the moisture on the surface. If concrete so dry as that had been used the difficulty mentioned would scarcely have been felt. I should fancy the *lias* lime must have been carried away by the water in solution. Of course, if the water had been incapable of flowing the lime would not have been carried, any more than the stones would have been carried away.

The PRESIDENT: When do you add your water? After it has been placed down?

Mr. DEACON: No. We make it as follows: In the ordinary process of mixing employed by contractors, a cubic yard of material is turned over by several men at once, and if properly watched a good result may be obtained, but this must be at the expense of unnecessary labour, for if the whole is sufficiently mixed some portions will be remixed unnecessarily; but in a large majority of cases mixing by this process was insufficient. I have found by experiment that the quantity of concrete most efficiently mixed by a single man is about one cubic foot, the following method is therefore adopted: The first process to be described produces a mortar consisting of one part of Portland cement and six parts of gravel. At each mixing-place there is a range of mixing-boards, each board about 3 feet square and having three sides 6 inches deep. The bottom is covered with sheet iron. To the back of the board is hinged an uncovered box, having a capacity of one cubic foot, and between each pair of boards is a small galvanized iron cistern, supported on galvanized angle-iron legs. From each cistern a pipe, provided with a rose and tap, projects over each adjoining board. The *modus operandi* is as follows: Each man stands at his own board. Behind the boards is a heap of gravel. Commencing at one end and proceeding to the other, a man shovels the gravel into the boxes hinged to the backs of the boards. As each box is filled, the cubic foot of gravel is tipped on to its board, and upon it a boy immediately throws one-sixth of a cubic foot of gravel from a measure provided for the purpose, and so on till the last board is charged. Each man turns over his gravel and cement in a dry condition to the satisfaction of the inspector; he then opens the tap communicating with the cistern, and allows water to flow

from the rose on to a bare portion of the board, and as the water flows he shovels the mortar on to it in thin layers, and then immediately stops the flow. By these means the mortar is uniformly wetted throughout, and no further mixing is necessary. Great care is taken to apply only sufficient water to cause the mixture to look damp when squeezed in the hand. This process being completed at the first board an empty wheelbarrow arrives, and having received the contents of that board proceeds to the next, and so on until filled, when it is wheeled away to be tipped *in situ*. Thus, then, a thoroughly mixed and cheap mortar was produced, and from it and other materials the concrete was made as follows: On the site where the concrete is to be placed is first scattered a layer of broken stone, brickbats, slag, or other suitable material—upon this the mortar is thinly scattered, and upon the mortar a second layer of broken stone is placed. The men next proceed to drive the upper layer of stones into the interstices of the lower layer with beaters in the form of large heavy spades with elongated handles. Then comes another layer of mortar, another of stone, and a second beating, and so on until the required thickness is reached. The result is a most excellent concrete consisting of a very large proportion—about twelve parts of broken material and gravel to one of Portland cement, in which, however, every stone is separated from and united to its neighbour by a layer of cementing material. When used for carriage-way foundations the surface is finished with the mortar and smoothed with the beaters, as perfectly as if done with a plasterer's trowel. I have not yet found any machine capable of making concrete so efficiently and yet so cheaply as the method I have described; though I have little doubt that such a machine might be produced.

The PRESIDENT remarked, that this was a very cheap way of making concrete. He had never heard of so much gravel being used before.

Mr. DEACON said it was almost more like gravel than concrete, but it had the strength of strong concrete. In answer to an inquiry, he stated that concrete in a liquid state was worse than useless.

Mr. ALLISSON: Yes, the less water you can put in concrete the better.

Mr. DEACON: if you want to get a homogeneous mass, you must make it with as little water as is necessary to get the chemical combination in the cement.

In answer to Mr. Cross,

Mr. DEACON said, the cost of the concrete upon the plan he had sketched out was about 20s. per cubic yard ; but then in Liverpool they had to pay a very high price for stone, and it was solely on that account that the figure appeared so large. They had to pay as much as 6s. and 8s. a ton for such stone as they were obliged to use, and 6s. a ton for gravel. Such prices, he supposed, were scarcely known to most present.

At this stage of the proceedings the President announced that he was compelled to leave in order to catch his train back to Bristol. He remarked that he had been much pleased with what he had heard and seen, and that the day had been a most successful one.

On the motion of Mr. Deacon, seconded by Mr. Morant, a vote of thanks was tendered to the President for the manner in which he had managed the proceedings.

The PRESIDENT, in reply, said the thanks of the Members were due to Mr. Cross, who had had the arrangements to make, and to Mr. Coghlan.

The discussion then terminated.

Subsequently the Members dined together at the Victoria Station Hotel, and this terminated the day's proceedings.

DISTRICT MEETING AT DARTFORD.

A MEETING of the Home and Eastern Counties District was held at Dartford, on Saturday, December 15, 1877.

The following Members of the Association were present: F. Ashmead, Memb. Inst. C.E., President; T. T. Allen, Stratford-on-Avon; L. Angell, Stratford, E.; J. S. Anscombe, Maidstone; E. Buckham, Ipswich; T. Cook, Ware; B. C. Cross, Dewsbury; H. Ditcham, Harwich; E. B. Ellice-Clark, Hove; T. Goodchild, Teddington; C. Jones, Hon. Sec., Ealing; J. R. Harding, Epsom; S. Honeycombe, Northfleet; J. Hope, Colchester; J. Lemon, Southampton; W. T. Lewis, Enfield; J. Maughan, Grimsby; H. Macauley, Kingston-on-Thames; J. E. May, Malling; F. Newman, Ryde; W. Noot, Tonbridge; E. Pritchard, Warwick; J. Procter, Bolton; E. M. Richards, Burslem; J. R. Rogers, Hornsey; — Storor, —; J. J. Smethurst, Sowerby Bridge; T. Walker, Croydon. Messrs. J. P. Davis and Howard A. Carson, of the United States, were introduced by Mr. Robert Rawlinson, C.B., as American Engineers anxious to hear Sanitary discussions and see Sanitary Engineering works in progress in England.

The District Secretary read the circular convening the Meeting.

The PRESIDENT: It is proposed to have a discussion on the Model Bye-Laws recently issued by the Local Government Board, and afterwards to visit the Dartford Section of the West Kent Main Sewerage Works. I will ask Mr. Angell to open the discussion.

Mr. ANGELL: As every member present must have had the circular which I sent round, as Surveyor to the West Ham Local Board, containing the conclusions at which a committee of that Board arrived, I can briefly condense the matter. The Model Bye-Laws are, generally speaking, worthy of acceptance, but on points about which we are anxious they are practically silent—first as to the manner in which the staff, by which they are to be carried out, will be remunerated for their labour. It is obvious that the very numerous clauses of these Model Bye-Laws will necessitate a great deal of supervision of building operations, laying out streets, and constructing sewers, and will therefore impose heavy additional

duties on Borough and Local Board surveyors. Now in the large towns this will not matter much ; for if extra work is involved the staff will be increased, but on the officials of smaller towns and districts it will be a question of great moment, and the work will press very heavily indeed. I brought this point recently before the West Ham authorities in whose district there is a large amount of building going on, principally by speculating builders, who cause a great deal of work and trouble to the executive, and having completed their buildings, walk out of the district without paying anything by way of recompense. Now in the metropolis, as you are probably aware, there is a special class of officers, the district surveyors, who carry out these duties of supervision, paid by a scale of fees chargeable to the builder, but the moment you step out of the Metropolitan area these powers cease. I will not now go into the question of the operation of the Metropolitan system. All I will say is that the work of the staff should be paid for by those deriving the benefits from it. There ought to be means for procuring payment for the services of a Local Board staff by those whom it is engaged for. That no kind of compensation should be made to the local authorities for their officers' work appears neither business-like nor fair. In West Ham, where there are between twelve hundred and fifteen hundred new buildings erected every year, a large amount of supervision is at present entailed on the staff, and I have induced the authorities to forward to the Local Government Board a report and memorial of the Bye-Laws Committee,* asking that Board to obtain such parliamentary powers as would enable local authorities to charge fees for supervision ; this memorial coming from an individual local authority will not have so much influence with the Local Government Board as it

*WEST HAM LOCAL BOARD.

ENGINEER AND SURVEYOR'S DEPARTMENT.

TOWN HALL, STRATFORD, LONDON, E.,

November 28, 1877.

MODEL BYE-LAWS.

DEAR SIR,—The proposed Regulations as to "New Streets and Buildings," Series IV. of the "Model Bye-Laws" issued by the Local Government Board, contain ninety-nine clauses in great detail, which, if adopted, will involve a considerable increase in the work and responsibilities of the Surveyor's Department, under the various sanitary authorities.

The Local Government Board, while thus suggesting a very large amount of extra duty, does not provide for nor suggest any additional remuneration.

I have drawn the attention of my Board to these facts, and they have memorialized the Local Government Board thereon, suggesting that parliamentary

would if sent up from all the urban authorities in the country. I have received a letter from Mr. Lynde, of Manchester, in which he objects to the proposal on principle, as he is of opinion that all duties of the kind involved by the Model Bye-Laws should be performed by the public staff of a district and not by the surveyor, and that such staff should be paid out of the rates, and not by fees. Now this might do in Manchester, but could not be done in small towns, there being no staff except the surveyor. We know as a principle of human nature, if there is a very large amount of supervision to be exercised, without adequate remuneration, it will not be performed. Apart from this question, I wish the Local Government Board would endeavour to afford us some protection in the discharge of our duties, for unless they do more

power be obtained to charge such reasonable fees on estates and buildings as will provide remuneration for the necessary staff involved in carrying out the Model Bye-Laws.

I enclose a copy of the resolution of my Board, and beg to suggest that you use your influence to support it by a similar memorial from your Board.

I am, dear Sir, yours faithfully,

LEWIS ANGELL.

WEST HAM LOCAL BOARD.

REPORT OF BYE-LAWS COMMITTEE, NOVEMBER 6, 1877.

"The Committee report that they have had under consideration the Bye-Laws for New Streets and Buildings, No. IV. of the 'Model Bye-Laws' issued by the Local Government Board.

"The Committee and the surveyor are of opinion that the adoption of the suggested Bye-Laws would generally, subject to questions of local detail, be of great public advantage.

"The proposed Regulations appear, so far as the Public Health Acts admit, to be the application of the Metropolitan Building Act to Local Board Districts, but with the important omission of the fees whereby the district surveyors are remunerated in the Metropolis.

"The Committee direct the attention of the Board to the great amount of detail in the proposed Bye-Laws, which contain ninety-nine clauses, involving an amount of continuous supervision which is impracticable with the present staff of the Board.

"The Committee are of opinion that it is just in principle that the owners of estates and buildings, whose works require the supervision of the Board's officers, should, as in the Metropolis, be charged reasonable fees for such supervision.

"The Committee therefore recommend—

"That before taking any action in the matter of the Building Bye-Laws, the Local Government Board be informed that this Board fully recognizes the desirability of adopting the Model Bye-Laws for Streets and Buildings, but they cannot enforce them without imposing much additional work on the officers, and therefore suggest that the Local Government Board should obtain parliamentary powers to enable Local Boards to charge, as in the Metropolis, such reasonable fees as will provide the necessary supervision for the enforcement of such Bye-Laws."

The above report was adopted.

to support us they can hardly expect we shall carry out their wishes *con amore* without being properly remunerated. As to the general principle I think you will agree that the speculating builders and others who develop property, should be called on to contribute their share of the expenses incurred in their behalf by the local authorities. I therefore move, Sir, the resolution which stands in my name—

“That the Local Government Board be memorialized to obtain parliamentary powers which will enable Local Boards to charge, as in the Metropolis, such reasonable fees as will provide the necessary supervision for the enforcement of the Model Bye-Laws.”

This was carried *nem. dis.*

Mr. JOSEPH HOPE (Colchester): Sir, I have much pleasure in seconding the resolution moved by the previous speaker, having had considerable experience in connection with building Bye-Laws; I agree with Mr. Angell in a general approval of the Model Bye-Laws, especially as they appear to give the surveyor an opportunity of exercising his discretionary powers in several matters where he is now allowed none. I cordially agree that there should be a scale of fees chargeable on those who cause the trouble and work for the local authorities and their officials, more especially on those who are constructing new buildings. It is desirable, however, that such charges should not be made a personal matter for surveyors. If the fees were payable directly to officers this would be the case, and provision should be made by enactment that these fees should be paid to the local authorities' credit in defraying the general district rate. It will then be the duty of the urban powers to provide efficient staffs, both in number and ability, to carry out the supervision that will clearly be required if the Model Bye-Laws are adopted, and there is a greater probability of such Bye-Laws being adopted and thoroughly enforced, if by so doing the ratepayers can be recouped some of the additional expense incurred, and if these payments by the speculators are not made personally to the surveyor. With this understanding, I will second the resolution.

Mr. JAMES LEMON (Southampton): Mr. President, I am of opinion that this Association should be careful in the steps they take in reference to this matter, and suggest that the Council might ask the Local Government Board to receive a deputation on this subject. It appears desirable that to some extent the Board should grant aid to local authorities for their surveyor, as they do

now in the case of the medical officers and sanitary inspectors. The great error of the Public Health measures, introduced by the Governments, has been, that they have produced Acts of a curative rather than preventive character; for it appears to me if sanitary works are carried out properly in the first instance there will remain very little for the Medical Officer of Health to do. But the more immediate question before us now is, How are these Model Bye-Laws to be carried out? I do not think many Local Boards will take the initiative in putting them into force, as it will give additional trouble and labour to all concerned in giving the new laws effect. In Southampton we have recently been engaged in framing Bye-Laws on the Metropolitan standard; but in the minds of the Council there was a great objection raised to the large staff that would be required to effectually carry out the regulations laid down; also as to many details in connection with them. For instance, it was considered 30 feet would be ample for the width of new streets, while you know 40 feet has been generally adopted. This is, I believe, a specimen of the manner in which Local Boards are likely to act throughout the country. The Local Government authorities should be asked to contribute a portion of the surveyors' salaries; when that Board decided to do so in the cases of medical officers and sanitary inspectors, the first act of the Local Boards was to raise the remuneration of those officers, thus attracting the services of a more able body of men. Again, proper protection should be given to surveyors in the discharge of their duties, just in the same way as medical officers are protected; the more supervision and restraint exercised on speculating builders and others, the more necessary will protection be. I have read the Model Bye-Laws, and on the whole do not see that there is much to find fault with. There are, however, many minor points on which I join issue with the framers; but it is clear that if these Model Laws are adopted and put into force, the duties of the surveyor will be such as to make him the most important officer in the service of local authorities, and in return, he should be paid a proportionate salary. This will not be done unless fees are paid for executing the Bye-Laws and Public Health Act. At present we see the anomaly of persons improving their properties out of the brains of surveyors without paying for them, for instance, in the laying out and construction of new streets. When notice is served under the 150th section of the Public Health Act, the owners never execute the works themselves; they always leave the

local authority to do it for them, because they find they get it done cheaper. Why? They save the expense of a surveyor. As to the disposal of the fees, we ought not for a moment to entertain the question of their being paid directly to the surveyor. There has always been a strong and influential feeling in the Metropolis against paying the district surveyor's fees, and I am convinced the Boards of Works will eventually pay those officers by salary. I am therefore of opinion, the Local Government Board are not likely to sanction a similar practice in provincial towns.

Mr. CHARLES JONES (Ealing): I approve of the resolution, but on the matter of fees shall most strongly object to any payments being made to the surveyor. If they are handed over to the Board's credit it will leave the surveyor in a far better position to carry out the Bye-Laws, and tend to promote a better feeling between him and his Board than if the fees are paid into his hands. This proposition being agreed to, I think we shall have greater probability of success with the Local Government Board.

Mr. E. BUCKHAM (Ipswich): The question of the revised Bye-Laws appears to have been ably discussed, and I would suggest that the best way of approaching the Local Government Board will be by memorializing it as an Association, remembering always that our personal interests must ever be a secondary question, and that our chief object is to assist in seeing their wishes carried out. We know, in doing this, when difficulties arise, the blame, curiously enough, is brought round to the surveyor, and these difficulties are increased by reason of owners of small property, frequently a powerful majority on the Local Board, taking action, so that the surveyor is placed in a most uncomfortable position. It appears to me a most important principle that fees should be paid into the District Fund, and that the surveyors should be left unfettered and absolutely free to discharge their duties, however unpleasant, fearless of personal consequences. These Model Bye-Laws appear to provide for a very large number of matters that no doubt have hitherto been overlooked, and enter into details where hitherto clauses have been too general; but I do not know whether any of the leading municipal engineers and surveyors have been consulted as to the practicability of enforcing these stricter provisions. Certainly, one would have thought, their experience should have been made available, and would of a necessity have been valuable, both as to practice and the probable effects they will have on the community. With regard to emoluments, I have, after some years'

thought, come to the conclusion that the Central Board should pay a portion of the salaries, or, while giving us additional labour, attempt to influence those by whom we are employed, for there can be no question of the fact, that there are a very large number of underpaid surveyors at the present time, and if additional duties are cast on them, it is only reasonable they should have additional remuneration. I shall vote for the resolution.

The PRESIDENT: It is proposed to put Mr. Angell's resolution first, and afterwards discuss the Model Bye-Laws. Previous to the motion being submitted, I should like to mention that I recommended the urban authority of Bristol to charge 5 per cent. on all new street works in addition to the actual cost of construction, and this has been done for some time past. I will now ask Mr. Angell to reply.

Mr. ANGELL: With reference to the mode of bringing this matter before the central authority, it will be much better to forward a memorial than to send a deputation; the various interests requiring amended or additional legislation are so active at the present time, that I fear the Government receive more deputations than they care about; but if we memorialize them we shall have more time and consideration given to our prayer. In addition to this, if a deputation received a decided answer in the negative, the question could not be re-opened without difficulty for some time. I quite agree with the speakers to the resolution, that the fees should be payable to the Board, who would not refuse to give their officer some portion of the revenue that he earned for them. But, apart from monetary considerations, I hold that there is a strong moral obligation cast on Local Boards and their officers to see efficient Bye-Laws carried into effect. In framing these Bye-Laws recently issued, the Local Government Board consulted the Council of the Institute of British Architects, who gave their advice merely and purely from metropolitan experience. For myself, I have no doubt there must be considerable variation for the provinces, more especially for northern manufacturing towns. Allusions have been made to the relations of the medical officers and the Local Government Board, and those allusions appear to have taken some kind of complaint. But we must remember in one respect surveyors should be exceedingly thankful to those gentlemen for the manner in which they have so forcibly pointed out the evils which affect the public health. They have educated public opinion to a point which insists that all drainage and building operations

shall be supervised by competent persons. They have helped to find the bread by which sanitary engineers live, and by-and-by we shall reap a greater benefit from the effects of this growth of public opinion.

Mr. PROCTOR (Bolton): I presume the words "Local Boards" in this resolution mean also Municipal Corporations?

Mr. ANGELL: Certainly.

The President then put the resolution—

"That the Local Government Board be memorialized to obtain Parliamentary powers which will enable Local Boards to charge, as in the Metropolis, such reasonable fees as will provide the necessary supervision for the enforcement of the Model Bye-Laws."

This was carried *nem. dis.*

Mr. E. B. ELLICE-CLARK (Hove): Mr. President, now that the Meeting has decided the question of fees on what appears to me to be a reasonable basis, I will, with your permission, call attention to the Model Bye-Laws just issued by the Local Government Board, which I have attentively perused. It appears to me they have been framed principally on the Metropolitan Building Act—numerous provisions which have, from time to time, been obtained by Local Acts—the Bye-Laws issued some quarter of a century ago, and a good deal of new matter; and while they contain that which is undoubtedly practicable and useful, they also contain many provisions that are superfluous and impracticable. Indeed, not only do I question whether any large town will accept them as a whole, and attempt to carry out their provisions, but I doubt many of them bearing the test of an action in the High Court; as they appear in some cases to be *ultra vires*. Commencing with Bye-Law 3, as to the level of new streets, it says that a new street is to be laid out at such levels as will "afford the easiest practicable gradients throughout the entire length, for the purpose of securing easy and convenient means of communication with any other street . . . with which it may be connected." This, no doubt is a most desirable thing. We frequently find persons laying out streets without any reference to the levels of adjoining streets, so that, as means of communication, they are useless. But can this be altered by a Bye-Law? I have in my mind a case decided by a Superior Court,* in which it was held that under the Public Health Act a person was not bound to lay out a new street at such levels as would admit of its being in communi-

* *Caley v. Kingston-upon-Hull.*

cation with adjoining streets ; and if that is a precedent, the new Bye-Law is of no value whatever. These are several Bye-Laws relating to the construction and width of new streets ; but, as in the Public Health Acts, not a word is said about mews, which, in my opinion, often come within the meaning of a new street, but which are uniformly treated otherwise ; it is important this point should be settled, as under existing and the Model Bye-Laws a mews may be made any width the proprietors wish. In Hove, there have been recently erected mews, probably 300 yards in length, 25 feet wide, with stables on each side, having dwellings above, with entrances at both ends. Also a mews of the same width, and so forth, being a *cul-de-sac*, both these have been held by eminent counsel not to come within the meaning of the words "new street ;" and that there is no clause in the Bye-Laws or the Public Statute that would meet the cases, the entrances to both mews being only 15 feet in width. This is clearly a matter that should be set right ; for, by this omission, the persons living over these mews are not so well provided with air space as those living in the "streets," and there can be no just reason why they should be denied air space simply because they happen to live in a place where there are always accumulations of manure and filth. Under Bye-Law 10, the entire site of a new building is to be covered with asphalt or cement concrete 6 inches thick. Now, however necessary this may be where there is a damp subsoil, saturated with liquid likely to be injurious to health, it is wholly and entirely unnecessary in most cases ; and I ask you as practical men, knowing the temper of Boards and their constituents, whether they could enforce such a stringent requirement, unless it was in very exceptional cases. The Bye-Law which specifies the mortar will meet what has been long wanted ; but is it possible to see it carried out ? The number of sections relating to the thicknesses of walls are also valuable, and appear to have been carefully considered, except that there is nothing to meet concrete walls beyond specifying that they shall be as thick as brickwork (Sec. b, No. 22). As this material is likely to be largely used in building operations, it is one that should have been dealt with ere vested interests and erroneous popular ideas on the subject had been formed. By No. 25, it enacts that when the external wall of a building is within 15 feet of any other building, it shall be carried up so as to form a parapet 1 foot above the highest part of any such roof or gutter which adjoins such external wall. If this means that in

detached houses a wretched and hideous parapet is to be forced down the throat of the architect, whether he will or not, such a Bye-Law not only could never be carried out, but I question any local authority attempting to adopt it. What is to become of large boards and overhanging gables in Gothic structures? Again, above the roof, flat or gutter, of the highest building adjoining, every party wall in the case of buildings of the warehouse class or public buildings, shall be carried up 3 feet, and in the case of other buildings 15 inches. There are a number of Members here to-day from the North of England, and one would be glad to hear what they and their Boards are likely to say to this. Then, in Section 2 of the same Bye-Law (26), a party wall is to be carried up 12 inches higher than any turret, dormer, lantern light, or other erection of combustible materials, if it is within 4 feet of an adjoining building. This one cannot characterize as anything but absurd; in Gothic architecture it would be hideous. Can we imagine any architect perpetrating such an abortion? Surely not. And when it is "duly coped or otherwise protected," what purpose will it serve? The question of placing timber in party-walls is most arbitrarily dealt with. No matter what the thickness of that wall is, no bond timber, plate, block, brick, or plug of wood is to be inserted in it. This necessitates the joists running from back to front, unless they are bedded on the bricks or stones; and in many other particulars is quite unnecessary. Bye-Law 34 recites that every bressummer is to have a bearing of 4 inches at each end, on a pier, "in addition to its bearing on a party-wall." What if the party wall is 18 or 24 inches thick? Surely this bearing should be regulated according to the weight of the superstructure and the width of the opening, and not dealt with in this general and hap-hazard fashion. The next Bye-Law (35) is also needlessly stringent, as all partitions inside a building are to be stopped with brickwork, concrete, or pugging. What will this have the effect of doing, but to do away with that just pride of the carpenter—the trussed partition? Again I say this is wholly and entirely unnecessary. Where chimneys are not rendered and parged, they are to be lined with stoneware piping *one inch* thick at least. Is this not most unusual? And how many chimneys are there in this country lined with stoneware at all, still less with pipes *one inch* thick? Once more: the dread of fire seems to be omnipresent with the framers; for by Law 52 every turret, dormer, &c., is to be externally covered with incombustible materials; so

that cleft oak or shingles cannot be used. Again I say this is wholly unnecessary. Then follow the sections relating to air space ; and a matter altogether new to Bye-Laws, and if I am not thoroughly mistaken, quite outside the powers conferred by the Public Health Act, is enacted in No. 52, whereby every new domestic building along the whole line of its frontage is to be 24 feet from the opposite side of the street, or the boundary of any lands immediately opposite. Now, this has been a provision in many Local Acts, but what has been the result ? It has pressed so arbitrarily on individuals that, rather than submit to it, they have used all kinds of means to avoid erecting new buildings ; they have patched up old ones, and too frequently left them alone altogether. This section is sure to have this effect ; Given a street now built of less width than 24 feet. A wishes to rebuild ; B, opposite, also. B waits until A has built and set back the required distance, then he is not required to give up any land at all. C, the owner next to B, wishes to rebuild : D, next to A, the same ; C is first in the field, and sets back 24 feet from D, who is in the same condition as B, and gains by waiting. This is clearly an attempt to widen streets out of the pockets of individuals, and not the community at large. Is it not unfair that because A holds lands (houses) in an old, narrow street, he should be compelled to widen that street without compensation ? If streets are to be widened, let it be done equitably and at the public expense. If the building line is kept, this provision, in my opinion, would not hold the test of an action. It would press exceedingly harsh on the owners of thousands of houses in narrow streets that require rebuilding : and, if put into force, those houses will remain old and dilapidated, instead of being rebuilt. Beyond mentioning the fact that privies may be constructed within 6 feet of a dwelling, I will say no more on the provisions in these Model Bye-Laws ; but will ask, If all these are to be carried out, what will be the rent of a labourer's dwelling ? Will the humbler classes be able to pay enough to secure a cottage to themselves ? Will it not rather have the effect of keeping them in small and unwholesome rooms and tenements ? I will venture to say, if every particular is carried out in the smaller class of house, no cottage could be let under ten shillings a-week ; and we may ask, How is the artisan to pay it ? And now comes the question, Who framed the Bye-Laws ? Was any single borough surveyor consulted ? Were the surveyors consulted as a body ? As a Member of this Association, I can tell you no. No com-

munication has ever been made to us. It seems a singular and remarkable fact that, from the drafting of the Public Health Act, twenty-nine years ago, to the drawing of these Bye-Laws this year, municipal engineers and surveyors, the very class above all others that could have given the best advice, had never been consulted. The consequence was they got both Statute and Bye-Laws that were unworkable, arbitrary, and inquisitorial. You have only to read the 150th Section of the latest Public Health Act, to see what a muddle we are in. There was a section that never was carried out, and that local authorities were now going to Parliament to get amended at their own expense for their own districts.* It is one thing to make laws and another thing to carry them out. These new Bye-Laws are very much in advance of any existing. Most towns and districts have now Bye-Laws; but in how many places are they carried out to the letter? I know large towns where there have been Bye-Laws twenty-five years, and only two cases have been before the justices. Do you suppose that they were never infringed? Before these new Bye-Laws are adopted, let those existing be carried out. Neither the local authorities nor the public were educated up to these stringent requirements, and it is no use making laws in advance of a people's intelligence. There was a great deal to be done before anything like such severe laws would be enforced by local authorities; they were not used to paying their officers, or employing sufficiently large staffs, to enable them to see all these requirements attended to, and a great change must take place in the constitution of Boards ere this could be done. Sanitary matters have improved very much during the past ten years; but not so far as to warrant the Local Government Board anticipating that the new Bye-Laws will be adopted and enforced throughout the length and breadth of the land. I beg to move, Sir,—“That the Council be requested to report to the Association as to the practicability of carrying out the Model Bye-Laws recently issued by the Local Government Board, and that a copy of such report be furnished to the Members to lay before their respective Boards.”

In answer to Mr. Jones, Mr. ELLICE-CLARK said he proposed that the Council should issue a report, somewhat similar to those prepared by the Royal Institute of Architects and the Liverpool Architectural Society.

* West Ham, Hove, and other places have adopted the clauses from the Metropolitan Acts.

Mr. ANGELL: Would you not carry the matter a little further? These ought to form clauses in a general Act, and not Bye-Laws at all. In many places they are sure not to be adopted, only three or four towns have thought of doing so, and there is no possibility of their meeting with universal acceptance; it would save a great deal of trouble if there was a general Act.

The PRESIDENT: There is another side to that question. Local circumstances make a great difference. In some towns there are already efficient Bye-Laws, and fresh ones are not required.

Mr. ANGELL: Some Members have said these Model Bye-Laws go too far; in my opinion they do not go far enough; while some of the most important clauses of old Bye-Laws are *ultra vires* and cannot be enforced. Although some may come within the scope of the Metropolitan Building Act, others do not do so; for instance, in these Bye-Laws not a word is said about hearths. Again, the height of rooms cannot be legally settled under these Bye-Laws, as there is a doubt in the minds of the Local Government Board whether power is given to limit this in the Public Health Act. For air space, cubical content may be insisted on, but the height should be specified. These and many other matters could be readily settled in a General Building Act. When the Royal Commissioners were sitting to take evidence on these points, not a single borough surveyor was called before them as to the working of these Acts. Although I wish the resolution went further, I will second it.

Mr. CHARLES JONES: One or two matters are very striking, and it is as well we should point out to the Council the peculiarities about these Model Bye-Laws. One important omission is, that not a word is said about existing buildings and alterations; in large districts alterations to dwellings are as important as new buildings, but there is no supervision proposed for these, as there appears to be no power under the Public Health Act. When, fourteen years ago, we were passing Bye-Laws for Ealing, I inserted a clause by which we should have had the supervision of existing buildings. We speedily found we had no power to carry it out. The omission as to the height of rooms is a most important one; no room should be less than 7 or 8 feet high. Again, in some situations, if we were erecting a residence for our own occupation, we might like to have such exceptional work as is provided for in the Model Bye-Laws, but to suppose that we can get this carried out in houses that are to be let for from four to eight shillings a-week is out of all reason. If matters of this kind are to be exacted, the rents of cottages, now

exceedingly high in large towns, will be so much increased that no individual working man will be able to rent one. It appears an unwise thing to make laws so stringent, not to say arbitrary, that nine builders out of ten will exercise their wits how to avoid them, as would be the case if another of these laws was enforced, by which a trench 18 inches wide is to be cut for a 6-inch pipe drain, to be filled in with concrete at least 6 inches thick. We, who know how much is done and how much is omitted, must look on such a law as ludicrous. Not one builder in ten thousand would do it. Here is another law which actually contradicts itself, and which does not appear to recognize the fact that kitchens are usually in basement stories. The 17th clause provides that the damp course is to be in cement, &c., beneath the level of the lowest timber, and not less than 6 inches above the surface of the ground, whereas No. 56 says the lowest floor shall have 3 inches between the lower side of the joists and the concrete. By a reference to the sketches, you will see in Fig. 1 the damp course is "6 inches above the surface of the ground level." By Fig. 2 it is "beneath the level of the lowest timbers." Which, then, under the Bye-Laws, is the place for the damp course? If as in either figure, the basement must be always damp; had the Bye-Laws enacted that there should be a dry area round every basement, the case would be met; as it is, we don't know where to put the damp course, as the Bye-Laws contradict each other. Then, supposing you happen to have a taste for Gothic architecture, and wish to have the roof timbers projecting over the walls and the gable ends protected from the weather by bargeboards, if you happen to build within 15 feet of another house your taste must go to the wall, for a parapet must be carried up for the imaginary danger of fire. You know how often we find when parapets are carried up, and the gutters are not sound, for plumbers are mortal, and a heavy fall of snow occurs, the upper ceilings are damp, and probably the front wall of your house is injured. These clauses surely have reference only to the buildings in the very heart of a town. Once more, in the 31st Clause we read that "in the party wall of a new building there shall not be inserted any bond timber, plate, block, brick, or plug of wood," so that whatever the thickness of the wall you cannot place wood in it. The ends of partitions, wall plates for joists, plugs for grounds, all are absolutely necessary in party walls; and as a matter of practice you know if 4 inches of brickwork be left between these small

timbers it is sufficient. I think in the Metropolitan Building Act $4\frac{1}{2}$ inches have to be left. These may appear small matters, but they very materially affect the construction of buildings. Our aim is to prevent the erection of bad building, and to encourage good work, but not to put unnecessary obstructions in the way of

FIG. 1.

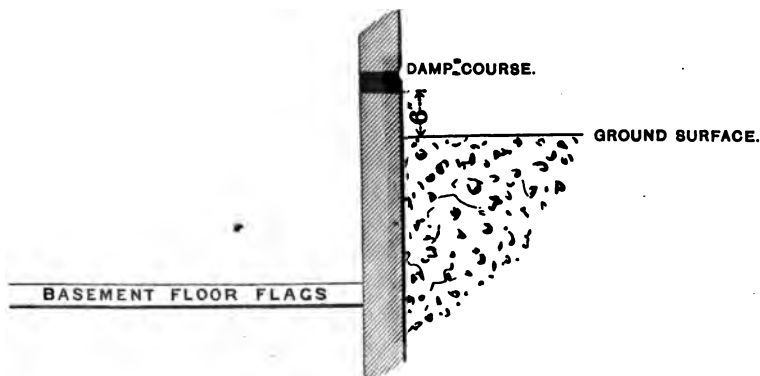
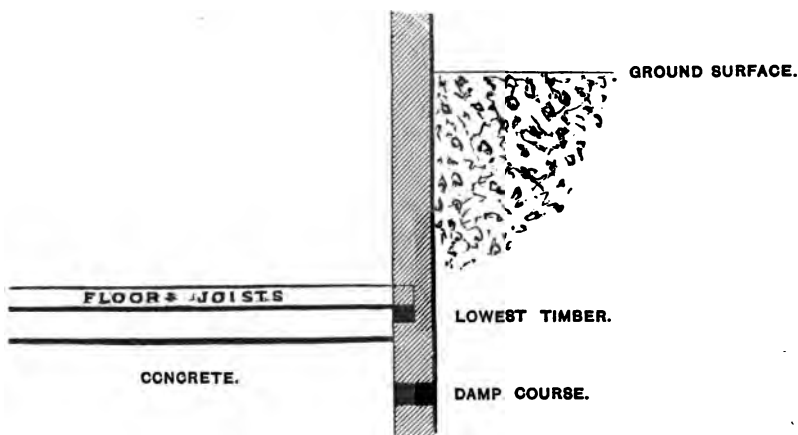


FIG. 2.



builders so that they will be endeavouring to foil us at every point. I am reminded of the Bye-Law as to partitions being of brick-work. Why "Nicholson" and "Tredgold" would have gone mad had they lived to see a restriction of this kind; and how can you

enforce a Bye-Law that says no turret dormer, lantern light, &c., is to be covered with anything else but incombustible material. If, for instance, you want to erect an observatory in the top of your house, a brick wall must be constructed of the same height, if it is within a certain distance of another building, and so you will obscure your view of the heavens in order to comply with these clauses. I believe a Committee of the Council will be formed to enter into these details, and I have pointed out these particulars so that a code of laws may be framed that will be useful and practicable; and my opinion is, if a series of General Bye-Laws could be incorporated in an Act of Parliament, it will be much better. A permissive Act is an unmitigated nuisance; it involves litigation; it involves personal difficulties with men who get on to Boards in order to control your operations, but if the Act is imperative there is but one course—the law must be obeyed.

Mr. T. NEWMAN (Ryde, I.W.): After going through the Model Bye-Laws I fully agree with them in most points, although they appear to be exceedingly stringent; still there are several important omissions that ought to be supplied. For example, in the exempted buildings, we are not informed whether notices of buildings exempted are to be given to the Authority. This is important, for until the surveyor has plans and sections he cannot decide whether or not the proposed erection comes under the exempted list or not. Then it should be settled whether plans once deposited become the property of the Authority or not, and whether such plans should be in ink. Plans are often left with me in pencil. This should not be allowed. They should be in ink, and the different materials distinguished by colour, otherwise they are documents that may be altered by anybody having them. These matters are not alluded to in the Bye-Laws. Then there is the all-important matter of alterations and additions. We know that if a building is pulled down to the level of the ground-floor it comes within the meaning of a "new building." But it is obvious that this can be, and is, evaded, and there are many alterations to old buildings as important as the erection of new ones. I had a case of a man wishing to add to an old house by building over an old imperfect drain. I stayed the work, but there was not a word in the Bye-Laws which authorized my action. The only point was that notice could be served to reconstruct the drain. Another point appears to me to be omitted. The laws are very stringent about new streets, but there is nothing to compel persons having the front of their houses to

the street; and a man may, if he chooses, build in the middle of a field. He may make a private road up to it and ask the local authority in a few years to take to it.

Mr. ANGELL: In that respect this is a free country. You cannot prevent a man building his own house on his own land in his own position.

Mr. LEMON: In reference to rebuilding, I may mention a case which recently occurred in Southampton. A building was nearly destroyed by fire, and when it was about to be reconstructed I wished the owner to comply with the Bye-Laws. This he refused to do, on the ground that this was an "old building," and outside the scope of the Bye-Laws, it not having been pulled down to the extent of one-half of the original cubical content, or to the ground-floor. I venture to think, if builders wish, there are few cases in which they cannot leave a few courses of bricks standing for a time so as not to come within the meaning of the term "new building." I should strongly support an Act of Parliament, and when I read a paper on the subject at Birmingham, the Members appeared nearly unanimous with me. But I think it a desirable thing that the Council should obtain information, and make a report on the whole subject.

Mr. HOPE: There would be no difficulty if the Legislature recognized the fact that old buildings should have restrictions placed on their being altered and added to. We have had no difficulty on that point in Colchester. There has been a question on the meaning of the word "intend," in reference to the Bye-Laws, as to laying out new streets. A case arose in which one house was erected in a street. Would that show the intention of a person to lay out a street?

Mr. ELLIOT-CLARK: In reply to the discussion, I thank you for your favourable expressions of opinion on the resolution. I cannot do that which some gentlemen desire; that is, amend the terms of the resolution by which the Local Government Board may be asked to make the Bye Laws an Act of Parliament. The local circumstances and requirements are so entirely different north and south that it would be virtually impossible to frame an Act that would bear the test of application to the whole country. An Act would and must be so general that it must miss essential points—*brevis esse laboro obscurus fio*. Endeavouring to meet every possible contingency concisely, it would pass over details. I believe, if Bye-Laws are carefully drawn by practical men, if they are practicable, exact, and moderate, we shall be able to secure properly built and

drained houses, and to construct good substantial roads and sewers. The omission of any mention in the Public Health Act of old buildings is a very serious one. I believe in Liverpool the additions to old buildings became so general that the Corporation obtained a clause to deal with the subject. Probably, when the next sanitary measure is framed this Association will be consulted, and the additions to old buildings is one of those matters that must be forcibly brought to the notice of a Royal Commission.

The resolution was put by the President, and declared carried unanimously.

Mr. B. C. CROSS (Drewsbury): On the 26th of next month there is to be a meeting of the Members of the Northern Districts, and it appears very desirable they should have an opportunity of expressing their opinions on this subject. Can I be supplied with a copy of this resolution?

The PRESIDENT: Certainly. The interests of the Association are so large in the north that it is essential the Members living there should discuss the Bye-Laws, and forward any resolutions they may come to, to the General Secretary.

Mr. CROSS: We have no Bye-Laws as to heights of buildings or construction of new streets; and many houses are being built back to back. We have very great difficulties in enforcing Bye-Laws.

Mr. NEWMAN: I would suggest that the Secretary should forward a circular to each Member, asking him his opinion on the new Bye-Laws.

The PRESIDENT: This will be properly considered by the Council.

The Members adjourned to lunch, and afterwards visited the West Kent Main Sewerage Works, under the guidance of Mr. Alfred Williams, Memb. Inst., C.E. The following is a description of the works handed to each Member:—

VISIT TO DARTFORD TO VIEW WEST KENT MAIN SEWERAGE WORKS.

BY PERMISSION OF SIR JOSEPH BAZALGETTE, C.B., C.E.,
CONSULTING ENGINEER.

History of Works.

THE towns and villages situate in the Valley of the Cray, as well as Beckenham, Bromley, and Chislehurst, like most of the towns in the Valley of the Thames, have long suffered from the want of effective drainage and the means of disposing of their sewage.

The Thames Conservancy Acts impose heavy fines for the pollution of streams and rivers by turning sewage into them, and every effort of the town authorities to purify sewage by deposition, or by irrigating lands in the neighbourhood of those towns, has been thwarted by the local opposition which such plans have raised. Thus, after several years of repeated struggle and defeat in this single-handed combat, and the expenditure of large sums of money in litigation and inquiries, it was at last suggested that by combination, the various towns might together be enabled to carry out more comprehensive works which would enable them to remove the sewage to some distant point where it would cease to be a nuisance.

In 1868 Sir J. Bazalgette prepared a scheme for the combined drainage of all the towns in the Valley of the Cray from Orpington to Crayford, which is almost identical with the Cray Valley branch of the scheme now under contract. The plans for this scheme were deposited with Parliament in the Session 1868-9, but the Bill was then opposed and defeated.

In 1871 Sir J. Bazalgette prepared plans for a combined system of sewerage and the disposal of the sewage of all the towns in the Thames Valley from Windsor to London on Bagshot Heath, and the plans were deposited in Parliament, but, owing to the want of sufficient unanimity amongst the town authorities, this scheme was not proceeded with.

In 1874 the Bromley Rural Sanitary Authority instructed Sir J. Bazalgette to prepare plans for the drainage of their district, which resulted in the deposit of Parliamentary plans for the following Session of 1874-5, for the construction of a main inter-

cepting sewer from Beckenham, forming an outfall for the sewage of Bromley, Chislehurst, Bexley, and Crayford; the Cray Valley sewer of 1868 forming a branch to this main outfall, and both uniting at Bourne Bridge, Bexley, into one sewer discharging into a reservoir situated on the Dartford Marshes on the banks of the Thames at Long Reach, and thence into the Thames upon the ebb-tide at a point about seven miles below the outfalls of the Metropolitan Main Sewers.

In devising this scheme in 1874, Sir J. Bazalgette proposed that the main sewer should be continued from Beckenham westward by Croydon, Mitcham, and Merton to Kingston, where it would form an outfall for the sewage of the towns in the Thames Valley, for the combination of which into one district a Provisional Order of the Local Government Board has recently been obtained; and it now seems more probable than ever that this outfall sewer, as designed in 1874, and now being constructed, is destined to become the outfall for the principal towns in the Thames Valley, and thus to solve a difficulty which has for so many years thwarted all the efforts of the Thames Conservators and the local authorities, and has imposed such heavy penalties on the latter.

To the zealous perseverance and public spirit of Colonel Lennard, the Chairman of the Rural Sanitary Authority of the Bromley Union (which comprises a large number of parishes) is due mainly the success of the West Kent Main Sewerage Bill. It became an Act towards the end of 1875, and by it was constituted the West Kent Main Sewerage Board.

Under their direction contract drawings were prepared by Mr. Alfred Williams, the Engineer, under the supervision of Sir Joseph Bazalgette as Consulting Engineer, and the contract was let, after many difficulties at starting had been overcome, to Messrs. John Neave and Son, the well-known sewer contractors.

The works were ordered to be commenced towards the end of 1876, and were begun in the neighbourhood of Halfway Street, near the Sidcup Station on the North Kent Railway. There have been nineteen shafts sunk down to the level of the sewer of from 40 to 65 feet below the surface, and three others are also being sunk which will soon be down to that level.

The sewer executed in tunnel is about 7200 feet in length, and a further length of about 13,500 feet has been constructed eastward of Penhill Bridge, in open cutting, at depths varying from 9 to 25 feet below the surface.

A length of about 3200 feet of the Cray Valley branch Sewer has been constructed between Bourne Bridge and Bexley. At the Outlet Works in Dartford Marshes a length of about 3600 feet of sewer is made, the floor of the reservoir and filters is in a forward state, and the works in river below low water are in progress.

The total length of sewer now constructed is about $5\frac{1}{4}$ miles.

In addition to the above, the contractor has on hand, ready for immediate use, a large quantity of concrete blocks and other material.

One important feature is that the sewer is being constructed in Portland cement concrete, instead of brickwork, and thus a considerable saving in the cost is effected.

A vote of thanks to Mr. A. Williams, Memb. Inst. C.E., for his courtesy in showing the Members over the works, closed the proceedings.

DISTRICT MEETING AT BRADFORD.

A MEETING of the Yorkshire District of the Association was held at Bradford on Saturday, January 27, 1878.

The following Members of the Association were present: F. Ashmead, Memb. Inst. C.E., President; J. Allisson, Assoc. Inst. C.E., Bradford; B. C. Cross, Hon. Sec. Yorkshire District, Dewsbury; J. Cook, North Brierley; E. R. Escott, Halifax; T. Hewson, Assoc. Inst. C.E., Rochdale; D. Hildred Batley, W. Scriven, Pontefract; J. H. Smethurst, Sowerby Bridge. Visitors: W. E. Heap, Rochdale; S. S. Platt, Rochdale; W. Thornes, Dewsbury.

The Members and visitors present proceeded to Frizinghall and inspected the system of Sewage defecation carried out by the Corporation of Bradford.

On re-assembling, Mr. B. C. Cross (Dewsbury) read the Minutes of the last Meeting, which was held at Sheffield, which were agreed to.

The PRESIDENT: I am happy to say that I hold in my hand the volume containing the Minutes of the Proceedings of the Association in 1875 and 1876.

Mr. Cross: I may say that I think it will be as well to go shortly into the Minutes of the Proceedings of the Meeting held at Dartford, on the 15th of December last. We went fully into the Model Bye-Laws on that occasion, and I think the President will say a few words with regard to what Mr. Lewis Angell proposed at that Meeting, and what was passed. I also think it will be as well at the outset to decide where the next Meeting shall be, and as we have not had anything like a Meeting at Leeds, I will suggest that the next Meeting shall be held at Leeds, in about three months. I have letters from several gentlemen regretting their unavoidable absence, but wishing us a successful Meeting; from Mr. Ellice-Clark, who was to have read a paper on the Model Bye-Laws, but who telegraphs to say that official business not only prevents him being present, but also has prevented him from

finishing his paper. From a great number of Members I have not received any replies.

The PRESIDENT: It is thankless indeed if when the Secretary sends circulars, the Members do not take any notice of them.

The PRESIDENT: The Members will notice in the circular, that Mr. Allisson intended to read a paper on the Sewage Works which we have visited, but for certain reasons it has been thought advisable that he should not do so. He has already given the Members the principles of the paper, but now perhaps he will give us a few words in addition. I may say on my own behalf and on behalf of the Members generally, that we were very much satisfied with the works, and with the effluent; I think that the whole process and the results were most satisfactory to the Members generally. I don't know whether any Member would like to say anything.

Mr. CROSS: I think, as Mr. Allisson has thought it advisable not to read a paper on the subject for very good reasons, which he has given, it would be advisable for me just to draw out a rough sketch of what we have seen this morning, and put in the information Mr. Allisson has given us this morning as to the discharge, the quantity of lime used, the expenses, and the number of gallons of sewage dealt with, and, I think, some general description with which Mr. Allisson has promised to supply us, that would get over any objection to Mr. Allisson not reading the paper.

The PRESIDENT: I quite agree that it will be the means of getting the information in our Minutes, perhaps in a better manner than if we had the paper.

Mr. HEWSON: I will take this opportunity of expressing my wonder at the great purity of the effluent; I have been on deputations year after year to visit various schemes, but really short of irrigation, I never saw anything so perfect as that they have at Bradford.

The PRESIDENT: That is quite my opinion.

Mr. ALLISSON: I believe our process has been very successful, still at the same time we have been going on in the same way you have seen us to-day for the last three years. I do think we are in as good a position as any borough in England at the present day; I think with a borough of 180,000 inhabitants we could not carry out a scheme of irrigation, and taking everything as it stands, I think we are really in a good position at this time.

Mr. SCRIVEN: I have great pleasure in supporting the remarks

which have been made, the samples of sewage which we saw in the two glasses show very satisfactory results indeed, and I am quite satisfied that the system is a very efficient one. I think the Secretary ought to have an analysis of the purified sewage; the water, although perfectly pure, has an exceedingly strong taste of lime, and it is a question whether it would pass the standard of purity required by the Local Government Board.

Mr. HEWSON: I have never even heard that a standard of purity has been fixed by the Local Government Board, and I think they never have fixed it; a commission recommended a standard of purity which has never been adopted; the powers that be, I believe, felt that they could not alter it, and it is left to the Judges in County Courts to say whether or not you have adopted all possible means to obtain a fair and reasonable standard of purity.

Mr. ALLISON: The Government have really never fixed any standard to go by.

Mr. CROSS: Although I think the sewage water of Bradford may be considered perfect having regard to the river it goes into, still I look upon it that a scheme may be applicable to Bradford which may not be applicable to a residential town in the south of England; I think myself that the water from these works is good enough to turn into any river in Yorkshire that I have seen, yet in the south of England, where the rivers are pure, where fishing goes on, and where they wish to preserve fish, it might not be so; if we could have given them an analysis, it might have been a good guide whether they should adopt such works or go in for irrigation.

Mr. SMETHURST: There can be no question that water turned out must be so that fish can live in it.

Mr. HEWSON: No, no.

Mr. SCRIVEN: No, no; it must be free from nauseous or excremental matter. For my part I think the Bradford system will suit us in Pontefract, and I can see no other that will. I agree with irrigation as being the best means, but it is not the cheapest by far.

Mr. SMETHURST: In my opinion if you put a fish in the water we have seen to-day it would die in ten minutes.

Mr. SCRIVEN: If you put it into the stream we have seen before treatment you would have a job to rear it.

Mr. SMETHURST: I am of opinion still that there is a standard of purity, but I cannot give the time it was fixed; I will inquire

into the matter before the next Meeting. I came to the conclusion that there must be a standard, because you cannot comply with any injunction unless there is a standard to work to, because you might say you will take the solids out first of all, and that will comply with the injunctions; if it would not comply, then there must be a certain standard.

Mr. HEWSON: You must pardon me, you are wrong.

Mr. CROSS: I think Mr. Hewson is quite right; a commission reported in favour of a standard, but the Local Government Board never issued orders on the subject.

The Model Bye-Laws.

The PRESIDENT: As some of the Members were not present at the Meeting at Dartford, it would be as well to inform them what was done there.

Mr. CROSS: I think before we can go into the question of discussing the merits of the Bye-Laws, it would be advisable for us to adopt the same resolution which was adopted at Dartford, and I shall be glad if any gentleman will move this resolution:—"That the Local Government Board be memorialized to obtain parliamentary powers which will enable Local Boards to charge, as in the Metropolis, such reasonable fees as will provide the necessary supervision for the enforcement of the Model Bye-Laws."

Mr. ALLISSON: I think we should go into the Bye-Laws first, and if there are any points which are considered unsatisfactory by the Members they might be included.

Mr. CROSS: I take it that every one here knows what the Model Bye-Laws are, and that every Member present has seen them, and knows what they contain; I think that the resolution has nothing to do with the Bye-Laws in detail.

Mr. HEWSON: If such power was got as that mentioned in the resolution, it would be a very valuable provision; I will move the resolution.

Mr. SMETHURST: I beg to second the resolution.

Mr. ESCOTT: I cannot see what has called forth these Bye-Laws; I cannot get at the bottom of why the Local Government Board should draw up such a code, because in most of these towns in the north we have special Acts applying to them, and on these Acts we draw up our own Bye-Laws. I cannot see the least advantage the town I represent would reap from Model Bye-Laws;

I believe the Town Clerk of Halifax has looked over them, and he is of the same opinion; I shall oppose the resolution, because I don't see the advantage of it.

Mr. CROSS: The Bye-Laws are not compulsory on any Local Board in the kingdom, but any Local Board can adopt them, if they think proper. If we were to adopt these as they are, the difficulty, I think, would be to carry them out at our place.

Mr. ESCOTT: Is there any Local Board or Corporation in the north who would think of adopting these Bye-Laws? There have been just two things which have struck me—that they have been drawn up by a medical officer, and that they are not any use in the north whatever.

Mr. ALLISON: That course which Mr. Escott has taken, I was about to take, but I thought the Bye-Laws ought to be gone through before that resolution was passed. There are one or two items which I may mention, and which I think might be amended; in the exempted buildings in clause 2, sub-sections H to J, referring to plant-houses, summer-houses, and similar places, not to be used solely or in part as habitations and workshops, I think the effect will be that the street lines will be interfered with; there seems to be no protection whatever for the street line, and you can build any of these different buildings close up to the line of the street. I think some provision ought to be made whereby these buildings can be kept back. There is no provision at all for isolation in the case of buildings for the reception of persons suffering from infectious diseases. Turning then to Section 17, which provides "that every house shall have a damp-proof course," I think that is really necessary in several cases for dwelling-houses and certain classes of workshops, but it gives you no explanation whatever how you have to carry it out in other buildings you erect. In certain classes of workshops, warehouses, &c., I think it is putting builders and others to great expense indeed. Section 35 says, "That every partition wall shall be stopped with brickwork, concrete, pugging, or other incombustible material at every floor and ceiling." Practically, this is doing away with lath and plaster partitions inside a house; I say if that was carried out, I think it would be carrying things too far, because in many cases you might not find it desirable to have such substantial partitions, and I don't think it would be feasible to carry out the section so strictly as we have it there. Then Section 67 says, "Every person who shall construct a water-closet or earth-closet in a

building shall construct such water-closet or earth-closet in such a position that one of its sides at least shall be an external wall." What I have to say about that is, that an earth-closet is not a suitable thing for the inside of a building at all. To Section 73, I say that 6 feet is not a sufficient distance for a privy to be from a dwelling-house. It should not be less than 12 or 15 feet, as the minimum distance; I say 6 feet is outrageous, and just think how you would like to have a privy stuck down at a distance of 2 yards from your drawing-room window! Section 80 is open to the same objection. If you adopt the restrictions of Sections 83, you must be prepared to abandon ashpits *in toto* from boroughs, for 6 cubic feet was too small entirely. Section 88 refers to the construction of cesspools; what I have to say in connection with this is, that there are no cesspools made watertight, and they are things which ought not to be allowed in towns; they might be allowed in the outskirts of towns, and there ought to be some clause stating that they would not be allowed within a certain radius of the centre of a town. Where cesspools are put they are never cleaned out until they are a decided nuisance, and they ought not to be placed inside a town at all.

Mr. HEWSON: It occurred to me in looking over those Bye-Laws that I ought to direct your attention first to page 5 in regard to Section 159 of the Public Health Act, which states what shall be considered the erection of a new building, the particular words are, "not originally constructed for human habitation." When we made our Bye-Laws in 1872 I find I had a clause similar to this put in, and I found the result was just this, that all the old houses that had become old and tottering, many of them being used as stables, &c., in the town, were immediately pounced upon and converted into houses because they had been originally constructed for houses. I got the Bye-Law amended, and it now prohibits the conversion into a dwelling-house of any building of any class whether it has been originally constructed for human habitation or not, I think in any such town it would be the same; and if a man had stables which had been originally constructed for human habitation they would be simply doctored up again into houses and you would not be able to object to them. I have made one or two notes of what I think desirable, for instance, with regard to drainage, I think it would have been a valuable addition to these Bye-Laws if the authorities had the power to take action against any unauthorized person interfering with and taking up the streets; we

have a list of contractors who are authorized to take up the streets, and they undertake to put the street in its original state; any person coming to the office wanting private work done he is supplied with a list of these authorized contractors, they have a list of these duties, and he selects which of them he thinks proper; the list of the contractors' duties is printed, plainly telling them what they are expected to do without any breach of the regulations, and if they do not complete the work properly they are struck off the list. The system works admirably, and I don't think there are any drains but what we hear of and inspect before the connection is made, and any person who interferes with the drains without permission is liable to be fined. It works very well indeed; people get their work done well, and it results in this way to the benefit of the owners of property, the parties by whom the drains are made, and the persons who do the work; the owners of property find that these men are under the control of the Corporation, and they send men to measure up to see whether the charge made is a fair and suitable charge. It also works well for the Corporation, in giving them an opportunity of getting records of the opening of drains; and, putting it in short, I think it would be a valuable addition if these Bye-Laws made it penal for any unauthorized person to lay or clean out sewers belonging to the town. You will find, in the fourth section of the memorandum on the first page, that the Public Health Act empowers every urban authority to make Bye-Laws as to the drainage of buildings; and I think it might be put in with it, that they shall be empowered to make Bye-Laws with respect to chimneys and smoke nuisance, I don't see that dealt with by the Bye-Laws; but I think there might be some Bye-Law made with regard to them stipulating what the height of the chimneys should be, regulating their height by the horse power of their boilers and the levels of the land immediately surrounding, because, supposing you say 40 horse-power boilers should not have a chimney less than 60 feet high; and that would be of little use if it was in a part of a town where the ground was rising rapidly, and where, say perhaps in 100 yards from the chimney, the land would be on a level with the top of the chimney. I think some clause might be inserted to meet this objection. Next, I think, with regard to the width of the streets, that the length should have something to do with the width of a street. Suppose a street was 50 yards long and only 10 yards wide, it would look a commodious street, but make it half a mile long, and it looks close as

it increases in length. I think that they ought to be made wider, so as to accommodate the traffic; if you have only a short street, the traffic will pass along easily, if it is not a crowded thoroughfare, but if it is a long street the traffic gathers and crowds each mouth. With regard to the damp course, I wonder what they would do at Oldham, if it were compulsory to put down a damp course on the basement floor in mills, where they require water running, to damp cotton and yarn.

Mr. Cross: There are a few things that have struck me also, and there is one point especially,—the Bye-Laws do not give any power to compel the uniformity of thresholds in streets that are on the sides of hills; I find no power to say what height the thresholds shall be, and I find the greatest difficulty with having to deal with them, because we have to make the causeways on different gradients to meet the difference in the heights of the thresholds. I think that the thresholds should be set out by the Surveyor, because it is impossible otherwise to have a properly formed street. I also think it necessary before any building is allowed to proceed, that they should be properly kerbed, so that we, who have to deal with the question of gradients, shall be able to lay it out according to the level of the threshold. With regard to the damp course, to which Mr. Hewson has called attention, the section says, "that every building shall have a damp course beneath the level of the lowest timbers." I think we ought to have power in certain cases to say that two damp courses should be put, I refer to cases where there are dwelling-rooms in the basement. With regard to Section 25, which says, "that every part of the external wall of a building is to be carried up so as to form a parapet 1 foot at least above the highest part of the roof," I think it is absurd. Section 31, which says that "a person who shall erect a new building shall not place in any party wall of such building, any bond timber, or any plate, block, brick, or plug of wood," is thoroughly impracticable; and I quite agree with what has been said that a distance of 12 feet is too little for privies to be from houses, and that the dimensions of ashpits as laid down in the Bye-Laws are not sufficient. Clause 91 requires that plans of streets laid out and delivered to the Surveyor shall be drawn to a scale of not less than 1 inch to every 44 feet; so far as I am concerned, I should prefer it to be 88 feet, which is the scale of the only Ordinance plan which we have. I do not think that any height stated in the Bye-Laws could regulate chimneys being higher than the

thresholds of houses in the immediate vicinity, there might be houses a few hundred yards from a chimney higher than the top of the chimney, and still there might be no nuisance, on account of the smoke, &c., from the chimney becoming dispersed by mixing with the atmosphere.

Mr. HEWSON: I don't mean that because a person builds a chimney on the lowest level you ought to look out for the highest points within the limits of the district, and say he must build higher than that. I mean that within a reasonable distance of the erection, the level of the surface and the relation to the intended height of the chimney should be considered.

Mr. SMETHURST: There is the 10th Section which requires that the whole of the ground surface of a new domestic building must be properly asphalted or covered with concrete, I don't see the utility of this Bye-Law generally. The 19th Section makes certain provisions, which means that if you build an ordinary cottage house, you must build a 13½-inch wall up to the roof; I consider that that is not necessary, and our friends the "jerry" builders must look out, and builders of back-to-back houses will have to look out if these Bye-Laws are adopted by any local authority. I think one of the best things that could be done, would be to get an Act of Parliament to make any Corporation who would not strictly enforce these Bye-Laws liable to a penalty. I argue that we cannot carry such Bye-Laws out. Other Local Boards act the same as ours do, and until we have some legislation brought to bear, and some strict Act put into force, in a form something like the Rivers' Pollution Act, the Bye-Laws will not be carried out. There is nothing mentioned in the Model Bye-Laws as to the construction of streets, although there are Bye-Laws as to the width and levels of streets, and to the effect that kerbstones shall be laid on each side of the carriage road. I think before this is done no new building should be erected or commenced, and that a Bye-Law of this kind is very important, because a man may purchase a field of ten acres in extent; he may submit plans to the Board and say I propose to make a street; after that he commences to sell very small plots, and it will be with difficulty that the work is carried out. If the Corporation were to compel the kerbstones to be laid along the street, and if they had such a useful Bye-Law, they could see whether the streets were properly sewered and drained before building operations commenced; nothing of the kind is provided in what are called the Model Bye-Laws.

The **PRESIDENT**: I consider Bristol is a place in an exceptional position altogether; we have our Bye-laws, and we do not want these Model Bye-Laws at all. I may say we have already provided for the matter provided for in the first resolution, for we now take fees from builders under a special Act, and we get about 700*l.* per year for this very thing, and we don't want Bye-Laws for that. With regard to Mr. Allisson's remarks about brick partitions as to their being abolished altogether by the adoption of these Bye-Laws, I quite agree with him. With regard to privies and ashpits being at least 12 or 15 feet from a house, as they are known here, we disown them altogether, as all our privies are connected directly with the sewers and all the excremental matter passes into the sewers without any manual labour at all; we do not require water, we find we have only periodically to flush them. Cesspools we do not allow at all, we make all our owners drain, and the scale of plan we adopt is 50. With regard to Mr. Cross's observations as to the levels of streets we require, before any houses are built, the sewers to be put in and the level of the street formed. The damp course must be a local affair entirely; but with regard to parapets, I think it is most unjustifiable that they should insist upon parapets being carried up to the ridge of the house; we never allow more than two houses to one privy, and every new house we require to have a separate privy.

Mr. Cross: I may state that we allow four new houses to one privy. The Model Bye-Laws are very strict in certain Bye-Laws as to the size of rooms, having them a certain area, &c.; but after a person has built a house and the Local Surveyor has passed it, there is nothing to prevent him dividing the house into any number of rooms he likes.

Mr. ESCOTT: After six months.

Mr. Cross: Yes, after six months, there is no power in any of those Bye-Laws to prevent him. As to the carrying out of the Bye-Laws there is no power to enforce it, and such Bye-Laws in many of the smaller towns about here are simply a farce.

Mr. ALLISSON: Mr. Hewson has made certain remarks about the Corporation of Preston authorizing certain persons to do certain kinds of work in the streets, I have thought over this matter, and I quite agree with him; our system at the present time is this—any person who wants to break into our streets for the purpose of making a connection with the sewers, comes to the office and gets permission from the office. The only charge made against them

there is 6*d.* for an agreement stamp, for an agreement to make the surface good; if they do not make the surface good, they are taken into court. Mr. Hewson says that he has got a list of persons authorized to do that class of work, and if they do not do it to the satisfaction of the Local Authority, they are struck off the list: I think that will be a very beneficial arrangement indeed, because I know in certain cases there is great trouble to get the work done as it ought to be done. I think as to the height of the chimneys it is set forth in the Smoke Prevention Act, what power you have to regulate the height of a chimney; in Bradford, the minimum height is 30 yards, and we do not allow a less height. As to the width of streets, I think where a street exists that is 150 yards in length, it ought to be intersected with cross streets. As to the uniformity of thresholds, I don't think that is at all necessary, because estate owners are bound to submit plans and sections, showing the width and level of the street, and they are in duty bound to carry out these sections. Parapets I agree are unnecessary. I cannot say much about Bye-Laws not been carried out, but I think it depends much upon the officers.

Mr. SCRIVEN: No, no; the authorities are to blame more.

The PRESIDENT: We have Bye-Laws according to which we cannot have houses nearer than 10 feet to the back of another house, 15 feet if they are two storeys, and if it is three storeys, 30 feet.

Mr. HEWSON: I don't believe that in the manufacturing towns of the north of England that these Model Bye-Laws can be carried out as regards to the stability of buildings, without increasing the rents of houses far beyond what the working classes would be able to pay: with regard to the strength of the walls, it would add perhaps 50 per cent. to the cost of a cottage, as they are built to-day in the north of England, and I object to them on that account. I have no objection to Bye-Laws for obtaining wide, well-paved streets, that insist upon healthy sites and demand water-tight buildings, but I object to them interfering with the strength of the timbers and the walls, and it is my opinion that one-half of the matters in the Model Bye-Laws are not required.

Mr. CROSS: I think if these things were left to be permissive we should have power to make a man put up what I believe to be fit for a house; there are certain cases where such power is absolutely necessary.

Mr. HEWSON: You have power to prevent them using dangerous

or unfit buildings. These Model Bye-laws have been made from the Metropolitan Bye-Laws, and in the south of England they do not know what we require in the north.

The PRESIDENT: It was stated at Dartford that no Local Engineer had been consulted in the matter, if there had been the Bye-Laws it would have been different. It would be almost impossible to frame Bye-Laws for all places alike, and we must have Bye-Laws suited to the various localities in which they are used.

The resolution as to the memorial to the Local Government Board on the question of fees was carried.

General Business.

Mr. ALLISSON proposed, and Mr. SMETHURST seconded, and it was carried (*nem. con.*), that the next Meeting of the Yorkshire District be held at Leeds at the latter end of April.

Mr. ALLISSON moved, and Mr. ESCOTT seconded, and it was carried (*nem. con.*), that a vote of thanks be given to the President for paying so much attention to the interests of the Association and for his presence.

The PRESIDENT briefly responded, saying that he considered it a duty and a pleasure to attend the Meetings.

Mr. CROSS proposed, and the PRESIDENT seconded, and it was carried (*nem. con.*), that a vote of thanks be given to the Mayor of Bradford for his kindness in placing his parlour at the disposal of the Association.

The Members and friends subsequently dined together at the Victoria Hotel, when a number of loyal and complimentary toasts were proposed and responded to.

BRADFORD SEWAGE WORKS.

The works are situated within five minutes' walk of Frizinghall Railway Station, and are about one and three quarter miles from the Bradford Town Hall.

The whole of the sewage of the borough, including a large proportion of water from the mills and works, is brought to this point, the quantity of which averages about 8,000,000 gallons daily. The outfall sewer is 6 feet circular, and is built of 9-inch brick-work in cement, and has a gradient of 1 in 300.

The sewage after leaving the outfall sewer passes over a series of catch-pits, where the heavy matter is intercepted; it is then run along an outer channel where it flows through a $\frac{1}{4}$ -inch screen, and passing underneath the building, discharges into an outer channel

on the other side; whilst discharging into this last-named channel, a stream of milk of lime constantly flows into and mixes with it; this channel is always fully charged with sewage mixed with milk of lime; the length of this channel is 750 feet, and the settling tanks occupy the same length, being 32 in number, as also do the filters. Between the channel and each settling tank there is a penstock, by attention to these penstocks, the settling tanks are alternately filled, and sewage is allowed to remain in each about twenty minutes for precipitation, after which time it is drawn off from the surface by self-acting valves; the sewage is then passed through upward and downward filters. The filtering material employed is coke-breeze, which is changed once a month, and which, after being dried, is then used as fuel. There are about 600 tons of coke-breeze used per annum. The quantity of lime (which is obtained from Skipton, and costs 12s. 6d. per ton delivered on to the works) used per diem is from 6 to 8 tons, according to the state of the sewage. The cost of treatment in 1877, including all expenses, except wear and tear and interest on capital expended, was 17. 8s. per million gallons.

There appears to be no detailed analysis made public, all the information to be obtained was that the public analyst had reported that all the matter in suspension was removed, and the greater part of the matter in solution. On the day the Members visited the works, the effluent was perfectly clear and free from all taste or smell except the taste of lime, which was very prominent.

The sludge is dealt with in the following manner, viz.:—The bottom of each settling tank has a sharp fall to one corner, where there is a penstock constructed after the manner of a retort mouth-piece; after the sewage has been drawn off, this penstock is opened, and the sludge, being in a very liquid state, flows through and into a sludge channel, which takes it into the sludge tanks at each end of the building; the gradient of this channel is 1 in 80. From these tanks it is lifted by a bucket elevator, and wheeled on to land adjoining the works, where it is used solely for the purpose of raising the land, which is very low. With about 15 per cent. of moisture it is reckoned that there is an accumulation of about 140 tons per week. Having so much land in the immediate vicinity that requires filling up, there has never been any difficulty in getting rid of the sludge.

The total cost of the works as at present is estimated at 20,000*l.*, and the present process has been in use since 1875, and is found to give very great satisfaction.

DISTRICT MEETING AT WOLVERHAMPTON.

MIDLAND DISTRICT.

THE Eleventh Meeting of the Midland District Committee of the Association was held in the Council Chamber at Wolverhampton (by the kind permission of the Mayor), on Saturday, the 27th of April, 1878.

Mr. F. Ashmead, Borough Engineer, Bristol (President of the Association), occupied the chair, and there were also present Messrs. Deacon (Vice-President), Borough and Water Engineer, Liverpool; E. Pritchard (Vice-President and Secretary of the Midland District), Warwick and Westminster; C. Jones (Honorary General Secretary), Ealing, W.; G. E. Thoms, Borough Engineer and Surveyor, Wolverhampton; Cole, Hereford; Lobley, Hanley; Eayrs, Newcastle-under-Lyme; Bayliss, Redditch; Allen, Stratford-on-Avon; Denis, Oldbury; Comber, Kidderminster; White, Oxford; Cartwright, Bury (Lancashire); Fereday, Wednesbury; Richards, Burslem; Newman, Ryde (Isle of Wight); May, Town Malling; Newton, Altrincham; Kenworthy, Handsworth; Cross, Dewsbury; McCallum, Stafford. The visitors included Ald, Hawksford, Messrs. Willcock (Messrs. Horsman and Willcock), Lyons, Wright, T. J. Barnett, Bryan, Broom, Adams (Manager of the Barnhurst Farm), Wolverhampton; C. Law Green, Resident Engineer, Yardley Sewerage Works; Marshall, Smethwick; Pewtress, Rowley Regis, &c.

The Minutes of the last Committee Meeting, held at Kidderminster, having been read and confirmed,

The CHAIRMAN said the next business was the appointment of District Secretary.

Mr. EAYRS begged to move the reappointment of Mr. Pritchard. He was sure Mr. Pritchard was a gentleman who had taken very great interest in the Association, and they could not have a better secretary.

Mr. COLE seconded the motion.

The CHAIRMAN said he could very cordially support the motion, which was then put and carried unanimously.

Mr. PRITCHARD said he would certainly do his best for the interests of the Association, although considering that he held no municipal office, he had his doubts whether he was quite in order in still taking an active part as district secretary.

The CHAIRMAN said as that matter was discussed before, and Mr. Pritchard was then reappointed, he thought it need not be entered into now.

Mr. PRITCHARD, after saying he should be glad to do his best for the Association, as he had done already in the past, went on to say that he had received several letters from gentlemen who could not attend the meeting. One of these was Mr. R. Rawlinson, C.E., who had also written to Mr. Thoms and forwarded some notes and observations written especially, he (the speaker) supposed, for that Meeting of the Association, which he wishes to be read, and, if time permitted, discussed. He (the Secretary) had taken upon himself to have the suggestions from Mr. Rawlinson, and also a paper that had been written by Mr. Thoms on the Wolverhampton Sewage scheme, printed for the purpose of easy reference and discussion. The expense would not be great, and the whole thing was done by the request of a number of members. He then read the letter from Mr. Rawlinson, and others from Mr. Angell, the first President of the Association; from Mr. Burnell, who was unable to be present in consequence of illness; another from the Surveyor to the Local Board of Health at St. George's, near Bristol; and one from Mr. Palmer, Surveyor of Malvern. The Secretary then proceeded to read the following suggestions, which had been forwarded by Mr. Rawlinson.

LONDON, 16th April, 1878.

TO THE ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS
AND SURVEYORS.

GENTLEMEN,—I cannot be with you in person, but I can take great interest in your proceedings, and beg to offer the following very brief remarks to your notice.

As some of you may be aware, it is part of my official duty to look over plans, details, and estimates, for main sewerage and sewage purification-works, submitted to the General Board for sanction to the proposed loan.

Some of you are likewise aware that I have prepared "suggestions" as to maps, plans, details, and as to main-sewers, house-drains, and water-supply; these plans and suggestions are not

elaborate or complete, but are in fact, what they are called, suggestions to be considered. They are, however, the outcome of experience and not of mere theory. Thought has been used in their preparation, and I submit that they deserve thought; not necessarily blindly to follow the rules indicated, but, rather, to master their spirit and purpose and mend upon them where practicable. Young engineers will find that no rules can be applied under all conditions.

There is, however, one rule which ought not to have any exception, namely:—That the engineer shall so design and construct his work that he shall be master of it and not that it shall be master of him. As for instance, any working parts of apparatus, such as cast-iron pipes and valves at impounding reservoirs, should not be so placed in the work as to render repairs or renewals impracticable. A cast-iron outlet-pipe should not be buried beneath the deepest part of an embankment, nor indeed in any part of any embankment, but should be laid in a culvert in such manner that pipes and valves may be inspected, repaired, or renewed, without disturbing one spadeful of earth.

Then as to main-sewers and house-drains. These have to remove fluids and certain detritus and other solids liable to find admission. Sewers and drains may therefore, at times, by improper use, or by abuse, become impeded, and it is necessary that the Engineer should have ready means of inspection, and that he should be in no doubt as to his power of inspection. Hence the suggestion that all sewers be laid in right lines from point to point, having man-holes at changes of line or gradient, and that sewers and drains be absolutely true in line and in gradient, also in cross-sectional form. A young engineer does not all at once see the necessity for this mode of designing and constructing, but if he will only complete one town in the manner described, he will find the subsequent advantages so great that he will never depart from the method. In ordinary towns, with populations of or below 10,000, man-holes with man-hole covers will be sufficient. For larger towns, or for streets of great traffic, there may be side entrances.

When a sewer is in a right line and has a true invert from man-hole to man-hole the surveyor can be in no doubt as to opening down to side-junctions at any intermediate point. And if the work is true in line and in form it is sound and good. And this is no small recommendation in favour of the principle inculcated.

Sewer and drain ventilation is absolutely necessary; this should

also be a rule without an exception, and I must caution sanitary engineers on this head.

Unventilated sewers have, over and over again, killed men as suddenly as a dose of prussic acid would have done. Concentrated sewage gas is deadly; diffused and diluted sewage-gas is without serious danger in the open air, but will be injurious within dwelling-houses, hence the necessity for abundant free external sewer and drain ventilation. There is an amount of ignorance and even of obstinacy on this head of main sewer ventilation which is not only lamentable, but, in so far as health is injured and life imperilled, it is criminal. Simplicity in arrangement and construction should be aimed at, and, so far as practicable, patents—as patented forms of sewer ventilators, patented street gullies, and I would also say, patent sewage-traps—should be avoided.

In construction, the young engineer should see that his materials are sound, and the mortar or cement the best. Portland, or lias lime will enable the engineer to execute sound and enduring work, and concrete made with either lime will be of the greatest use.

Earthenware pipes for sewers and drains are now most extensively used; these should be strong, sound, and true in form, but the best pipes may require to be sorted and selected to ensure even and true joints.

As to jointing sewers and drain pipes, clay is usually used. If the trench is water-tight and the pipes are evenly and solidly bedded, well-tempered clay may be used, but in rock, gravel, or sand, rich Portland concrete should take the place of clay; as in a dry trench clay will crack, and so cease to make a tight joint.

At the upper ends of all sewers there should be full ventilation and flushing power.

At the outlets of all sewers there should be means to prevent the wind blowing in, and so driving sewer gases back to the town.

Sewers may have flat gradients, that is, small fall, and be made to work, but such sewers must be true in gradient line, and there must be water at command for flushing.

Sewers having steep gradients should be broken into a series of steps, so as to diminish the velocity of flow.

Cess-pits or catch-pits should never be formed on a line of a sewer, but, as much as practicable, silt, or road grit should be prevented from entering sewers, especially pipe sewers having flat gradients* and small diameters.

* "Flat" does not mean a flat invert on cross-section, but small fall.

Sewer trenching is, in some cases, difficult work, and in all cases requires care. Sound looking ground should be securely stayed, and loose, wet, and quick or running sand will require special attention, not only in opening out the ground, but in constructing the sewer.

Earthenware pipes are not suitable for quicksand, unless extraordinary precautions are taken, and then there will probably be a crippled and irregular line of sewer constructed at great cost. In such cases it may be cheapest to substitute cast-iron pipes, which may be of less diameter than earthenware or brick, as such pipes (cast-iron) can be worked full and even under pressure.

When a pipe or brick sewer has been laid, great care is required in filling the trenches and in drawing the timber to prevent the falls of earth, especially in clay; as a set or fall of clay from the side of deep trenches may crush pipes, especially at the joints, and may even crush and distort some brick sewers.

As sewer trenches are, for the most part, in towns, the streets having houses on both sides, and as main sewers, to be of practical use, must be deep enough to drain basements, great care must be taken to prevent damage to house property. In narrow streets, the houses may require to be stayed as well as the trenches, and in some cases it may be necessary to leave all or a greater portion of the timber and fill in over the sewer with concrete as well.

There will, however, be cases where discretion will dictate an alteration of plan by the abandonment of some specially difficult and dangerous route, and making the outlet for sewage in some other direction. This may be where the sewer would be exceptionally deep, the subsoil exceptionally bad, and the house property in the street exceptionally valuable.

I will offer a few remarks as to plans, specifications, bills of quantities, schedules of prices, and contracts.

Plans should be neatly and clearly drawn.

The cross-sectional dimensions and the gradient being written on the plan of sewers, there should be a title and scale on each plan, as also on each sheet, and the date, with the name of the engineer or surveyor clearly written, so as easily to be read. This, as a rule, should be in the right-hand corner. Many names are so written that experts cannot read them, and plans are frequently sent out having no title, nor any scale, nor any name.

Plans of details, such as side-entrances, man-holes, flushing chambers, and sewer-ventilating arrangements should be at 4 feet

to an inch. Larger works may be at 4, 10, to 20 feet to an inch. Clear, understandable, and measurable details are desirable. A young engineer may take this counsel to heart, that unless he thinks his work well out, and clearly delineates it on his drawings, he will never be safe in his execution, or gain that which ought to be most dear to him, a sound reputation. He had better therefore consider this well at the outset, namely, that reputation and success do not come by accident.

Fame goes before no man
But follows after him.

Specifications should be as clear and as short as is practicable. Stringent specifications, if contested, may prove to be the weakest. A specification should be common sense.

Bills of quantities and schedules of prices should be full, and the form of tender should be short and definite.

Lump-sum contracts are not desirable in sewer and drain work, but payments according to a schedule of prices; there may be monthly payments on account and a final measurement.

I am not writing an essay, but remarks as they occur, the outcome of experience. I have much trouble in looking over defectively prepared plans and crude, ill-understood, and ill-digested schemes as they are submitted to the Local Government Board for approval and sanction to a proposed loan. One great fact connected with the Board must not, however, be overlooked. It is not an office of works. It does not undertake to devise, neither does it make itself responsible in any degree for the plans, or for the estimates which may have been sanctioned. Each engineer and each Local Authority must both devise and execute the local works, and the district must alone be responsible for the local expenditure. The Board neither dictates as to works nor superintends works, but reserves the power of refusing sanction to a proposed loan, and of requiring full explanations as to failures in the works, or as to expenses over estimates, before sanctioning a supplemental loan. The reason that the Board declines responsibility ought to be clearly manifest. Plans and details may be the best possible; but the ultimate result depends on daily local supervision, and this the Board does not give; neither local action nor local responsibility is superseded.

All work connected with sanitary engineering should tend to increase of comfort, improvement of health, and lengthening of life;

and as in this world there is no value but in and through human life, there are no duties of greater importance than those belonging to, and devolving upon, the Associated Municipal and Sanitary Engineers and Surveyors of Great Britain. Every member should realize this, and strive, in his work, to leave the district, village, town, or city, better than he found it; that there shall be money's worth as the result of the labour and capital expended.

Each sanitary Engineer is, in his works, writing history which will be more enduring than the loftiest and proudest architecture. The seat of civilization may change. The strength and glory of England may depart, but the sewers and drains now being buried in the earth will remain to attest her wisdom in having provided for the comfort and well-being of her teeming population in the day of her greatest riches and power, the sites of her great seats of population, as now in the East, being indicated solely by ruins.

(Signed) ROBERT RAWLINSON.

The CHAIRMAN said he did not see that there was anything to discuss in the paper, as it treated upon the various subjects referred to very exhaustively. He thought, however, it was only right that some member of the Association should propose a vote of thanks to Mr. Rawlinson for the paper.

Mr. C. JONES, of Ealing, said this was the second time Mr. Rawlinson had communicated with them, and it was certainly due to him that a note should be forwarded to him by the Secretary, thanking him on behalf of the members for his interesting paper. There might be some things in the paper which would strike those who were old in the work as things that had gone before, but there was much in it for the young to lay to heart. No doubt, as stated in the paper, many plans and schemes were drawn up without being sufficiently thought over, and in that imperfect state were sent up to the Local Government Board. He himself had been wont to hear remarks made by Government inspectors as to the crude and unworthy character of schemes that were sent to the office of the Local Government Board, and it was evident that Mr. Rawlinson was speaking of things that he had seen. He had much pleasure in proposing that the thanks of the Meeting be forwarded to Mr. Rawlinson, for the kind paper he had sent to them.

Mr. PRITCHARD said he had great pleasure, as Secretary for the

Midland Committee, in endorsing what Mr. Jones had said in reference to the kindness and good wishes shown by Mr. Rawlinson to that Association from the very first. It had been his pleasure he believed on the occasion of nearly every meeting to receive a communication from Mr. Rawlinson, expressing the liveliest interest in that Association; and the paper he had kindly sent to them that day, although it did not leave much for discussion, still it pointed to what was absolutely necessary to be acquired and attended to, and foreshadowed the difficulties that the Local Government Board and their inspectors had to meet with in plans submitted for approval, and applications for loans for sanitary works. He had personal experience at the present time of a district in the north of England, where he was making investigations in consequence of the non-compliance with certain suggestions made in the paper that had just been read, and he could quite understand Mr. Rawlinson's feelings in calling attention to the difficulties with which that paper dealt. He had great pleasure in seconding the vote of thanks to Mr. Rawlinson for the paper with which he had favoured them, and for the kindness which he had always shown to them as a body.

The CHAIRMAN also desired to say that he fully endorsed what had been said by the mover and seconder regarding Mr. Rawlinson, and he had great pleasure in putting the motion to the meeting.

The motion was then carried unanimously.

The following paper by Mr. G. Eastlake Thoms, C.E., Borough Engineer and Surveyor of Wolverhampton, was then read by Mr. Jones.

MEMORANDUM AS TO WOLVERHAMPTON SEWERAGE.

By Mr. G. EASTLAKE THOMS, C.E., BOROUGH ENGINEER
AND SURVEYOR.

Mr. Henry's Scheme.

In September, 1854, the Council instructed Mr. H. Rawlinson, C.B., to prepare a scheme for sewerage of the borough; but in consequence of that gentleman being ordered by the Government to proceed to the seat of war as a Sanitary Commissioner, it was referred to Mr. D. J. Henry, C.E., the Borough Engineer, who, in December, 1855, submitted the scheme shown on plan marked "A," by which it was proposed to drain 955 acres at the south-east of the town into the Stow Heath brook, at the height of 431 feet above Ordnance datum; also 1345 acres on the western side of the town, by three mains, into the Graisebrook, at Compton Road, at a height of 341 feet above datum; and 470 acres at the north-east, by two mains—a high and low level—into the Gorsebrook, at a height of 372 feet above datum. Mr. Henry estimated the cost at 50,951*l*.

Messrs. Purnell and Dangerfield's joint Scheme.

It appears that the first serious attempt on the part of the Town Council to determine this question was taken in December, 1858, about ten years after the incorporation of the borough, when a Special Committee of its members was appointed to consider and report as to the mode and cost of efficiently sewerage of the borough. This Committee inspected the sewage works of a number of towns, and were so favourably impressed with the system (precipitation by lime) carried out at Cheltenham under the direction of Mr. Dangerfield, that they requested that gentleman to report as to the adoption of a similar system at Wolverhampton. In his report Mr. Dangerfield condemned Mr. Henry's scheme on account of the three outfalls, and recommended the Committee to construct their sewers with one outfall, near the lock at Compton, in accordance

with the plan marked "B," prepared by Mr. E. J. Purnell, C.E., who had for the last two years occupied the position of Borough Engineer. The outfall sewer of this scheme would in its course have passed the lowest land in the borough, at such a level as to admit the drainage of the whole area of the borough.

In August, 1859, the Committee reported to the Council in favour of the adoption of the scheme advocated by Mr. Dangerfield, with works for treating the sewage with lime, at or near the outfall, from which the effluent water was to be discharged into the canal below Compton Lock, or, as an alternative, into the Tettenhall Brook. Although estimated at 54,071*l.*, the Committee proposed to borrow 60,000*l.* for the execution of the works; but no action was taken by the Council on the Special Committee's report.

Mr. Purnell's Scheme.

Eighteen months after, in January, 1861, Mr. Purnell submitted a second scheme, shown on plan marked "C," which in all essential particulars corresponds with that of Mr. Henry, the lines and directions of the main sewers and the three outfalls being identical. The estimated cost, however, was only 35,000*l.* In November of the same year the General Sewerage Committee reported in favour of this scheme, and in January, 1862, the Council confirmed the action of the Committee. After the lapse of fifteen months, in February, 1863, Mr. Curley, C.E., of Hereford, having been called in to examine the levels, reported approvingly of the scheme, but suggested that the three outfalls should, for the purpose of filtering the sewage, be each raised 5 feet. The Council adopted Mr. Curley's report in April, and the Home Secretary was applied to in June for permission to borrow 37,000*l.* for carrying out Mr. Purnell's scheme. A local inquiry was held by Mr. Rawlinson in December, 1863, and the sanction for the loan granted within a few days of the date of the inquiry. Tenders were obtained in October, 1864, for the first contract, but the Committee deferred the acceptance of any of the tenders, pending the settlement of certain legal questions. About this time—the end of 1864—Mr. Purnell resigned, and was succeeded in the Borough Surveyorship by the late Mr. Anthony Morgan, C.E., and the three schemes were from this date virtually abandoned.

The only practical outcome of the discussion, which had ranged over ten years, was that the sanction of the Home Office had been obtained for a loan of 37,000*l.* for sewerage purposes, but it may

be fairly assumed that by this time the Council were alive to their responsibility in the matter.

Mr. Morgan's Scheme.

In April, 1866, Mr. Morgan submitted a scheme for draining a greater portion of the borough (quoting from Mr. Morgan's report) "into the adjoining parishes of Tettenhall and Bushbury, as also into the parishes of Codsall and Brewwood, by gravitation, for the purpose of irrigating land in those parishes." Mr. Morgan's scheme, which was estimated at 39,820*l.*, was at once approved, and application made to the Home Secretary for permission to borrow an additional sum of 3000*l.*, making 40,000*l.* in all, which was granted in September of the same year. The scheme, as originally proposed and shown on plan marked "D," provided for the deep drainage of 2650 acres within the borough, and for the irrigation of 970 acres of land, 20 of these being situate within the borough and 950 outside the borough, about one mile north-west of the town. The plan marked "E" has been prepared to show the actual areas drained and the quantity of land which the Corporation have been enabled to obtain for irrigation purposes. It will be seen that the lines of sewers within the borough are identical with those proposed in Mr. Morgan's original scheme, and the following brief description will suffice:—

The south-west intercepting sewer has a length of 3 miles 1 furlong, and is built of brickwork throughout, with a sectional area at its junction with the outlet sewer of 3 ft. 9 in. \times 2 ft. 6 in., which diminishes to 2 ft. \times 1 ft. 4 in. at the summit. It drains an area of 1327 acres, containing 7338 houses, with an estimated population of 36,690. The gradients vary from 1 in 45 to 1 in 500.

The north-east intercepting sewer is 2 miles 4 furlongs in length, with gradients of from 1 in 66 to 1 in 358. It is constructed of brickwork, and varies in size from 1 ft. 6 in. diameter at its commencement to 3 ft. 6 in. \times 2 ft. 6 in. at its junction with the outlet sewer. Near its termination it is joined by the Stafford Road sewer, which latter is built of brickwork, 2 ft. \times 2 ft. 4 in. and has a length of 3 furlongs, with gradients varying from 1 in 32 to 1 in 317. The total area drained by the north-east intercepting sewer (inclusive of the Stafford Road sewer) is 819 acres, containing 7201 houses, and a population of 36,005.

The main outlet sewer is of brickwork, 5 ft. diameter, with a

gradient of 1 in 1760. It is 1 mile long, and drains an area of 2146 acres, with 14,539 houses, and a population of 72,695, and terminates in an open duct at the southern extremity of the farm.

The sewers generally are constructed in right lines on the principles recommended by Mr. Rawlinson, and are ventilated through openings in the manhole covers.

Farm.

Negotiations were opened by the Committee in October, 1866, for the purchase or taking on lease of about 75 acres of the Dunstall estate of the late Mr. Hordern, on which it was proposed to utilize the first portion of the sewage. Owing to their failure to come to terms, the Council, on the 8th February, 1867, petitioned the Home Secretary to be allowed to take the land under compulsory powers of purchase. Mr. Hordern sent a counter-petition, and a local inquiry was held in March by Mr. Arnold Taylor, which extended over three days, and resulted in a compromise being effected, by which it was arranged that the Corporation should not take any lands forming part of the Dunstall estate, but should be allowed to lay their main sewers through the estate, and acquire other easements. Shortly after this the Corporation agreed to purchase of Mr. Hellier the Barnhurst farm, containing 283 acres, for the sum of 27,915*l.*, the low lands of this farm, comprising 150 acres, being included in the areas scheduled by Mr. Morgan as suitable for irrigation purposes. Possession was obtained at the end of 1867. In March, 1868, the farm was let to Mr. William Taylor, on lease for seven years, and in June of the same year the works of the first contract were commenced, the foundation-stone of the sewage duct being laid by Mr. Hawksford, who, as chairman of the Sewerage Committee for the last twelve years, has, to the great advantage of the town, ably conducted the negotiations, and spared neither time nor trouble to ensure the success of the scheme.

Sewage was first brought to the farm in the autumn of 1870, and it gradually increased in volume until 1873, when the works in the town were completed, and the old sewers connected. On May 16th of that year, Mr. Morgan gauged the sewers at the outfall and ascertained the dry weather flow to be 1,530,038 gallons.

It was soon found that the arrangement by which the farm was let to Mr. Taylor, on a seven years' lease, did not give satisfactory

results, and on payment of 1000*l.* compensation to Mr. Taylor, the Committee obtained possession of the farm in December, 1873.

The low level land now amounts to 200 acres, and forms a portion of the area of 950 acres scheduled by Mr. Morgan as suitable for irrigation for the purpose of his original scheme. Of the land at this level 135 acres may be characterized as of strong soil with gravel and sand subsoil; of the 135 acres, 56 acres are cultivated and underdrained 4 feet to 6 feet deep; 20 acres are cultivated without underdraining, and 45 acres are underdrained and used as filtration areas and not cropped; 14 acres were only acquired last month and have not yet been dealt with; 65 acres are of peat; with gravel and sand subsoil, of this area 26 acres are cultivated and underdrained 4 feet to 6 feet deep; 25 acres are underdrained and used as filtration areas and not cropped; and 14 acres are only recently acquired.

The high level land is 129 acres in extent, and the whole is cultivated. Of this area, 116 acres have a light soil with gravel and sand subsoil, of which 30 acres are underdrained 4 feet to 6 feet deep, and 13 acres have a strong soil with clay subsoil. The total area of land cultivated is 232 acres, of which 128 acres are underdrained 4 feet to 6 feet deep. The outlets for the high level effluent discharge into the canal feeder and Wergs brook, whilst those from the low level enter the Pendeford brook and canal feeder.

Works at Farm.

These are simple, consisting of two sets of settling tanks, a set of filter beds, and two impounding reservoirs for storm water. The settling tanks are 15 feet wide by 5 feet deep, and have a length in the aggregate of 350 yards. They are constructed of blue brick in mortar, the bottoms are formed to the segment of a circle, and the sides have a slope of 1 to 1. The main carriers are constructed respectively of brick, cast-iron, and earthenware pipes.

As Wolverhampton is practically a non-water-closet town, the sludge taken from the tanks consists principally of road detritus, and has therefore little manurial value. It amounts to 600 tons per annum, of which about 300 tons are sold to the farmers at 1*s.* per load, and the remainder used on the farm.

The filter beds occupy an area of 1500 square yards, and are formed of blast-furnace cinders, 2 feet thick, broken to pass through a 2½-inch ring; below the cinders, and resting on the concrete floor is a bed of horse-shoe agricultural drain tiles, 12 inches deep.

In times of storm the larger quantity of water has not time to pass through the filters, and they act chiefly as settling tanks.

The impounding reservoirs, for storm water, each holds three million gallons: the bed in each case is the natural soil—sand and gravel—drained from 4 feet to 6 feet deep. The effluent water from No. 1 reservoir passes through a 15-inch pipe into the Shropshire Union Canal, whilst that from No. 2 empties into the Wergs brook, a tributary of the Pendeford brook. Each of the reservoirs takes about six days to empty. They were not at first contemplated, but were constructed in 1874 in consequence of the Committee being ordered by the Staffordshire and Worcestershire Canal Company to remove the outlet for storm waters, which up to this time were allowed to enter the canal.

Mr. Morgan's Supplementary Scheme for Irrigating the High Land, purchased as a portion of the Barnhurst Farm.

In 1873 an ingenious supplementary scheme, known as the High Level scheme, was carried out by Mr. Morgan, for the purpose of intercepting the drainage of 500 acres of the highest land in the borough, and conveying it by means of a 12-inch cast-iron pipe to a level sufficiently high to irrigate the upper lands of the Barnhurst farm. Mr. Morgan estimated the population of the area intercepted at 21,000, and the amount of dry-weather sewage at 756,000 gallons per day of 24 hours, equal to 36 gallons per head, and that 400 acres of land would be required for the utilization of that volume of sewage, but no additional land at this level has as yet been obtained. Gaugings taken on the 24th and 25th instant give the dry-weather flow into the High Level system as 331,000 gallons per 24 hours; Low Level system as 1,544,000 gallons per 24 hours.

DETAILS OF COST OF SCHEME AS EXECUTED UP TO
MARCH 25TH, 1878.

Low Level Main Drainage Contracts	£45,816	
Ditto ditto Wages	1,387	
High Level Scheme	6,245	
Compensation	4,444	
Town Survey	888	
Sundries	1,924	
		60,704
Land, 329a. 2r. 23p.	36,710	
Works on Estate	11,524	
		48,234
Total cost of Scheme, exclusive of costs of Arbitration and works ordered in the Award		<u>£108,938</u>

The interest, &c., on the above sum represent a rate of $9\frac{1}{2}d.$ in the pound, on the value of property assessable to the Borough Improvement Rate.

Difficulties of Irrigation.

In treating the sewage by irrigation the Committee have to contend with two difficulties: the one, insufficient land; the other, the noxious ingredients sent into the sewers, chiefly by the galvanizers. The necessity of treating the sewage on an insufficient area has led to serious consequences, for, in spite of the strictest care, unpurified sewage-water in times of storm passed bodily into the Pendeford brook and its tributaries without undergoing downward filtration through the drains—wide surface irrigation does not purify our sewage.

Actions were commenced about three years ago by the owners and tenants of the land abutting on the brook to recover damages, which they alleged had been caused by the fouling of the brook from sewage matter; also by the drains being blocked at their outlets into the brook, and by their land being flooded with sewage water. They also claimed compensation for the damage arising from the large quantity of water sent into the brook over and above that due to the natural rainsheds of the district. The actions were referred to Mr. W. Fowler, Surveyor of Birmingham, who awarded the several plaintiffs damages amounting in all to 1880*l.*, and also ordered the Corporation to execute certain remedial works, the chief of which are—1st, the deepening of upwards of four miles of brook course; 2nd, the construction of a water-tight bank 2 feet high round the farm; 3rd, the formation of an additional impounding reservoir and settling tanks. The arbitration, damages, and costs, amounted to 3990*l.*, and the works, of which the first two are in progress and nearly complete, are estimated at 7500*l.* The deepening of the brook course and construction of the storm tanks will be of great service to the farm.

In consequence of the destruction of crops of wheat and ryegrass on the high level area, the Committee last year ordered the Borough Analyst to report on the liquids sent into the sewers by various manufacturers.

As being of great importance it is here given in its entirety.

Report from Mr. E. W. T. Jones, F.C.S., Borough Analyst, to the Wolverhampton Sewerage Committee, on the nature of Manufacturers' Spent Acid being calculated to injure the sewers and the vegetation on Sewage Farm.

29th September, 1877.

This is in reply to the inquiry through the Town Clerk, dated the 23rd June last.

I received from Mr. Broom, the acting Borough Surveyor, four samples of liquid on the 4th of August last, and from Mr. Thoms, the present Borough Surveyor, four samples on the 12th September instant. The samples from Mr. Broom were simply lettered A. B. C. D. respectively, but those from Mr. Thoms were labelled as to their source, to these I have added E. F. G. H. respectively, for sake of easy reference. I show on an accompanying tabulation the results of my careful analyses.

Each of the samples contains some iron in solution associated with a mineral acid known more generally as Muriatic Acid or Spirits of Salts. The purest of the samples contains iron in solution equal to nearly $\frac{1}{4}$ oz. of Green Vitriol per gallon, together with some free Muriatic Acid, which is enough to make it destructive to vegetation. The iron contained in the worst sample is equal to $27\frac{3}{4}$ oz. of Green Vitriol per gallon, together with some free mineral acid; it is therefore capable of making an enormous amount of liquid pernicious to vegetable life. All the samples, too, contain some Chloride of Zinc, which is also particularly antagonistic to vegetable growth.

I will now proceed to answer the questions put to me, aided by the analyses.

Question 1.—What is the chemical character of the fluid flowing into the sewers from the works using acid in galvanizing and other such manufactures?

Answer 1.—In galvanizing works the acid generally used is Muriatic, or Spirits of Salts, and then the "Spent Pickle" to be discharged is an acid solution of Muriate or Chloride of Iron; in other galvanizing works Oil of Vitriol is used, and then the spent acid is a solution of Sulphate of Iron, known when crystallized as Green Vitriol, this would be the waste of tin-plate makers, who also use Oil of Vitriol. Brass-founders use Nitric Acid or Aqua Fortis, but I do not imagine their spent acid is thrown away, it having a high marketable value, being a solution of copper, which is

easily recoverable. All the samples I have analyzed for this inquiry show the use of Muriatic Acid or Spirits of Salts, and I believe are all from galvanizing works; the iron present is as Chloride of Iron, but I show its corresponding amount of Green Vitriol, as being more generally known than the other salts of iron.

Question 2.—What is the chemical character of the same fluid when it arrives on the Barnhurst Farm?

Answer 2.—When these solutions arrive at the Barnhurst Farm they are considerably diluted, the Free Acid may be neutralized, and some of the Iron Salts decomposed by substances met with in the sewers, but this neutralization can only be very limited where a large quantity is discharged at the same time.

Question 3.—What effect will it have upon the fabric of the sewers?

Answer 3.—The "Spent Pickle," resulting from the use of Oil of Vitriol, would not damage the fabric of the sewers to anything like the extent that Spent Muriatic Acid would, because this latter acid dissolves lime very rapidly, and forms therewith an exceedingly soluble salt. Muriatic Pickle being found in all the samples before us, I consider the liquids are calculated to do damage to the sewers, by decomposing the mortar or cement, in dissolving out the lime, &c.

Question 4.—What effect on vegetation and the land?

Answer 4.—All soluble Salts of Iron are particularly antagonistic to every kind of vegetable life. There are tracts of land the soil of which contains, disseminated through it, iron pyrites, which are absolutely barren in consequence of Sulphate of Iron being formed by continual oxidation of the pyrites.

Question 5.—What are the best known practicable means of depriving this fluid of qualities destructive or injurious to vegetation or land, or injurious to the sewers?

Answer 5.—I know of no practicably cheap means of depriving the solutions I have analyzed of their injurious acid and irony properties, except by treatment with Caustic Lime; this will neutralize the acid and precipitate the iron as an oxide, harmless to vegetation; and I consider if this oxide be collected and dried, it would furnish an excellent gas

purifier ; the liquid resulting from the treatment would be harmless to vegetation when diluted with the other sewage. Although this is the only means I can suggest for dealing with the "Pickle" from the use of Muriatic Acid ; when Oil of Vitriol be used, perhaps the best treatment would be to concentrate the solutions by evaporation, and crystallize, to form the Green Vitriol of commerce, value about 50s. per ton. Some firms utilize all their Spent Oil of Vitriol in this way, but such a procedure is impracticable when Muriatic Acid is the pickling agent, because the resulting Salt of Iron does not crystallize with any degree of facility to form an article of commerce. There appears no reason why all galvanizers should not use Oil of Vitriol instead of Muriatic Acid for pickling their plates ; the expense would not be greater, and I have it from a reliable source, that in so doing there is an actual benefit to the quality of the sheets. If Oil of Vitriol were generally used, the process of crystallization, with the production of Green Vitriol, would be applicable.

Question 6.—In what way can such means be most effectively applied by the manufacturer, having regard to original outlay and annual cost ?

Answer 6.—In case of the precipitation method, the "Spent Pickle" being put into a tank, Milk of Lime is added until the whole of the iron has been precipitated ; after subsidence of the precipitate, the liquid may be run into the sewer, and the oxide dealt with according to circumstances dependent upon its intended use.

I show the amount of Lime required per gallon for each of the liquids analyzed. About 30 lbs. of Lime will be required for every Carboy of Muriatic Acid used, at a cost of about 2½d. per Carboy for Lime.

The crystallization process simply requires the solutions to be concentrated to a certain degree by boiling in leaden vessels, the Green Vitriol crystals forming on the liquor being allowed to cool.

Nothing has yet been done by the manufacturers, and the Committee are averse to erecting works for the treatment of the sewage with lime or other precipitants at the farm, being determined to enforce the provisions of "The Wolverhampton Improvement Act, 1869," which places on the manufacturers the onus of

ANALYSES OF LIQUIDS FROM SEWERS.

Received from Mr. Broom on the 4th August, 1877.					Received from Mr. Thoms on the 12th September, 1877.			
A.	B.	C.	D.	E.	F.	G.	H.	
Grains per Imperial Gallon								
Total Solid Matter dried at 100 C	106·40	5398·40	308·00	330·40	10998·40	420·00	1192·80	484·4
Iron equal to	21·76	1040·66	71·07	83·86	2436·67	43·51	314·73	111·68
Green Vitriol about	108·02 $\frac{1}{2}$ oz.	5166·13 11 $\frac{3}{4}$ oz.	352·81 $\frac{3}{4}$ oz.	165·60 $\frac{1}{2}$ oz.	12096·33 27 $\frac{3}{4}$ oz.	215·97 $\frac{1}{2}$ oz.	1562·42 3 $\frac{1}{2}$ oz.	554·41 1 $\frac{1}{2}$ oz.
Hydrochloric Acid	67·45	5007·80	184·98	166·58	9185·22	214·62	945·35	419·02
Sulphuric Acid (So ₃)	2·40	50·47	14·42	4·80	40·86	2·40	9·61	14·42
Zinc	Little.	LargeAm't	Little.	Little.	LargeAm't.	Little.	Little.	Little.
Lime required about	51·7 $\frac{1}{2}$ oz.	8841·5 8 $\frac{3}{4}$ oz.	141·90 $\frac{1}{2}$ oz.	127·8 $\frac{1}{2}$ oz.	7046·2 16 $\frac{1}{2}$ oz.	164·6 $\frac{1}{2}$ oz.	725·2 1 $\frac{1}{2}$ oz.	321·4 $\frac{3}{4}$ oz.

N.B.—1 oz. avoirdupois is 437·5 grains.

E. W. T. JONES, F.C.S.,
Borough Analyst.

neutralizing the acids and other noxious matters before entering the sewers.

Results of Farming Operations.

The results of the working of the farm for the past four years are as follow:—Year ending 25th March, 1875, deducting working expenses and interest, at 4 per cent. on working capital, there was a profit of 645*l.* on 236 acres under cultivation, and taking the rent at 2*l.* 10*s.* per acre (a fair price), we get a net profit of 55*l.*, equal to 4*s.* 8*d.* per acre. Year ending 25th March, 1876, 1049*l.* gross profit on 248 acres, calculating on the same basis, we get a net profit of 429*l.*, equal to 34*s.* 7*d.* per acre. Year ending 25th March, 1877, 1008*l.* gross profit on 243 acres, which gives a net profit of 400*l.* 10*s.*, equal to 32*s.* 11*d.* per acre. Year ending 25th March, 1878, 1205*l.* gross profit on 232 acres, or a net profit of 625*l.*, equal to 53*s.* 10*d.* per acre cultivated. These results, considering the adverse conditions under which they are obtained, are not a little remarkable, and give substantial evidence of the energy and ability of the farm bailiff, Mr. Adams.

Areas in the Borough not Sewered.

One-third of the borough is as yet unsewered, and of this area 782 acres—comprising 141 acres at the south-east and 641 acres at the north and west—cannot drain into the existing system.

In the Merridale and Newbridge districts—part of the area of 641 acres unable to drain into Mr. Morgan's system—the number of villa residences is rapidly increasing. The sewage of a portion of the former district is at present conveyed by an old sewer and discharged direct into the Graisebrook, at the Compton road bridge, whilst the latter district is temporarily sewered through a settling pit into the Staffordshire and Worcestershire Canal, but the Canal Company may at any time order the removal of the outlet sewer. The Sewerage Committee are of opinion that the time has arrived for considering the question of an efficient system of drainage for these districts, and have instructed the writer to report on the subject.

Instead of preparing a scheme for sewerage to the lowest of the three natural outfalls—that to the west of the town near Compton—and *then* looking for land on which to utilize the sewage, it is evident from his report, dated April 10th, 1866, that Mr. Morgan *first* selected the irrigation area, and *then* laid out his system of sewers with the object of bringing the sewage to that

area, for the report commences by stating; "I have surveyed the lands on the north-western side of the borough, in the neighbourhood of the Autherley junction, with a view of ascertaining the practicability of utilizing the sewage of the borough in that direction," and goes on to say that "the area that I consider may be drained into the adjoining parishes of Tettenhall and Bushbury, as also into the parishes of Codsall and Brewood, by gravitation, for the purpose of irrigating land in these parishes, is 2650 acres." And it is further evident from the fact that Mr. Morgan's intercepting sewers, in converging in the direction of the farm, meet and join the main outfall sewer at a height of 25 feet above the ground level of the lowest natural outfall, at a distance therefrom of about a mile and a half.

It will be ultimately necessary to take a considerable quantity of sewage to the south-west of the town, to be utilized on land in that direction, and the writer is of opinion that the whole of the town should have been sewered into one system, laid out somewhat on the lines of the scheme recommended for adoption by the Special Sewerage Committee, and shown on plan marked "B;" but that, instead of providing an outfall at Compton lock and erecting sewage works there, it should have been taken to the neighbourhood of Orton, a distance of four miles; or even to Highgate Common and the adjoining district, a distance of eight miles, where an unlimited quantity of suitable land might have been obtained on advantageous terms.

A discussion followed the reading of this paper.

Mr. WHITE: There is one question I should like to ask. I see it is stated in the paper that Mr. Fowler, Surveyor of Birmingham, adjudged that the Corporation of Wolverhampton were liable to execute certain works below their farm, of scouring, deepening, and widening the brook course. My question is, Whether it was ascertained that the Corporation were legally liable to do these works; or whether, to make the question more general, any corporation is liable for the flooding of lands below their sewage farms by reason of the influx of water into their drainage over and above the ordinary rainfall. I think that is an interesting point. I don't know whether Mr. Thoms can give us any information on that point.

Mr. THOMS here intimated that he would hear all the questions first, and then reply to them in their order.

Mr. EAYRS: I should like to ask whether the Wolverhampton

Improvement Act, 1869, which "places upon the manufacturers the onus of neutralizing the acids and other noxious matters from their works before entering the sewers," is now in force, seeing that the Rivers Pollution Act allows manufacturers to discharge their acids into the sewers providing they are not injurious to the public health?

Mr. DEACON: Perhaps Mr. Thoms will give us the depth of the high level syphon pipe below the outlet at the farm. I should also like to ask whether that sewer, with the almost flat gradient of 1 in 1760 yards, deposits any silt, or whether it requires flushing?

Mr. NEWTON: In Mr. Thoms's paper there is the expression "Wide surface irrigation does not purify our sewage." I would ask whether this is solely due to an insufficient area, or to the fact that the ground is not properly drained? The question is, whether the writer of this paper will give us any reason why a system of wide surface irrigation will not purify the sewage? Whether, in fact, it is due to a limited area or that the land is not properly drained?

Mr. PRITCHARD: There is one paragraph in the paper as to the working of the farm. I think it is now two years ago that considerable interest was manifested in the country by the statement that the sewerage farm at Wolverhampton was a source of profit to the Corporation. That was denied by some gentlemen who professed to have some knowledge of the matter, but now we have it on the authority of Mr. Thoms that there is a profit after paying or allowing for rental. What is put down is no doubt a fair price, but it is not shown in the paper whether or not any allowance is made for interest on the original outlay and working capital. This is a very important point, because, generally speaking, we have been led recently to look upon the utilization of sewage as not being so beneficial as it was at first prophesied or predicted that it would be. There is another point that affects the ventilation of sewers. We are told in the paper that the ventilation adopted here is by means of the open system to the streets, and I would like to ask what has been done in reference to house drainage connections, and whether a similar system of ventilation has been observed with respect to "wing" drains or private connections?

Mr. JONES: The question which Mr. Newton has put just now I would also put. The point raised is the more striking, inasmuch as Mr. Thoms in his paper states, "Wolverhampton is prac-

tically a non-water-closet town." That adds still more to the difficulty alluded to by Mr. Newton. For being a non-water-closet town, there is little more than the overflow of cesspools to deal with. It occurred to me whilst reading this paper that we have no data as to the term of years for which the sums of money mentioned are borrowed; and it is a matter of interest to ascertain whether the money is borrowed for a term of twenty, thirty, forty, or fifty years, as knowledge on this point would somewhat influence our calculations as to profit and loss. I find in that portion of the paper referring to this point that you (Mr. Thoms) allow 4 per cent. for interest on capital, but there is nothing mentioned with respect to the repayment of the principal sum, whether that is in any way taken into account or not I cannot tell. Of course that question arises in connection with the other question of the length of time over which the repayment of the money borrowed is extended, whether twenty, thirty, forty, or fifty years, and depends upon whether you have reckoned the repayments of capital as a deduction from profits. Our friend Mr. Pritchard is, I know, very anxious to prove that large profits may be made out of sewage farming, but we want some clear data upon which to make our calculations.

MR. PRITCHARD: If I may be allowed to interrupt, I may say that I had intended calling attention to the sewage farm near Leamington. It is a farm belonging to the Earl of Warwick. I made a statement at Portsmouth, and I was taken to task by the Mayor of Portsmouth, as to whether that farm did or would return a profit to the owner. Here is a letter I have received from the agent to the Earl of Warwick, Captain Fosberry, in which he says:—

"You ask me what the result of last year's operations on Lord Warwick's sewage farm has been. I am glad to be able to tell you that after paying the rent of the farm, a payment of 450*l.* for the sewage to the Corporation of Leamington, and interest at the rate of 4 per cent. on the whole of the capital invested in the undertaking, there is still a good balance in hand representing a clear profit. As you are well acquainted with the manner in which the farm is laid out, I need hardly tell you that this success has been attained mainly from having expended comparatively so small a sum in the levelling and laying out beds, &c. A great deal of money has been wasted on other farms in this way, and I am convinced from experience that a sewage farm cannot pay if it is

burdened with the extravagant outlay which has been thought necessary in laying out many of the farms now in operation."

That letter (continued Mr. Pritchard) was my reason for calling attention to the question of profit in connection with the Wolverhampton farm, as that and the one of Colonel Jones at Wrexham, together with Lord Warwick's, appear to be the only three that do show any profit, and that is the most interesting subject at the present time. We had begun to look upon these sewage farms, if they paid their own expenses as satisfactory, or even if carried on at a slight loss. It is well to explain that this farm at Leamington is a stock farm, and not an ordinary sewage farm. It is eminently adapted to receive the sewage; the land is of a very favourable description, and they have some of the best stock imaginable upon it.

In reply to a member, Mr. PRITCHARD added: The land is all treated with sewage, and in this sense—it is broad irrigation. There is a minimum percentage of sewage upon the greatest percentage of land, and I believe that represents some 300 acres which receive the sewage of a population of 20,000.

Mr. JONES: Then we may take it that is the highest class of high farming. We don't want to put a false interpretation upon irrigation, but this farm is highly favoured, and being a stock farm everything is produced upon the farm to put into the ground, and I take it that everything that is produced is put upon the backs of the beasts. Therefore everything is done to produce the highest results. They have no carting to market, but take the produce on four legs.

Mr. KENWORTHY: I find in this paper that the whole of the rainfall of these 2000 acres goes into the 5-foot culvert. If that is so, I should be glad to know if there has ever been any flooding, or if the whole of the rainfall is dealt with on the farm, or if there is any outfall?

Mr. THOMS: Mr. White asks, Are we liable for the extra quantity of water brought into the brook by reason of our taking the drainage from one drainage area into another district? In other words, whether we are legally liable for bringing an excessive quantity of water into the brook beyond that of the district?

Mr. WHITE: My question was really whether it was ascertained if the Corporation is legally liable to this extent, or whether the legal liability was overlooked?

Mr. THOMS: The legal liability was not decided. The matter was referred to Mr. Fowler, a land surveyor of Birmingham of

some eminence, who gave his award in favour of the plaintiffs. That being the case, we may be said to be liable, but we have never admitted our legal liability. The matter was referred to a surveyor, and you could not expect a surveyor to give a legal decision. Of course there were other points considered. For instance, there was the fact that the land drains were blocked up by noxious matters in consequence of the sewage being allowed to overflow unpurified into the brook.

Mr. WHITE: Was it not proved that the overflow was caused by this brook not being scoured out by the persons whose land it flows through?

Mr. THOMS: Clearly the brook had not been cleaned out for some years, and we have now done it under Mr. Fowler's award.

The CHAIRMAN: I am afraid this question of liability will not help you in the matter.

Mr. THOMS: With respect to Mr. Eayrs' question as to the manufacturers and the Rivers Pollution Act, I am not able to speak about the Rivers Pollution Act at all; but our own Local Improvement Act is in force, and by that all manufacturers are compelled to use the best-known scientific and practical means for neutralizing the acids and other noxious matters of that kind before allowing them to enter the Corporation sewers. That is what they have not and are not doing. I think what they wish is that we should neutralize the acids at the farm, and that the Committee are determined not to do.

Mr. EAYRS asked whether the Rivers Pollution Act would not neutralize the Local Act.

Mr. THOMS: I cannot say. With regard to Mr. Deacon's question as to the depth of the syphon pipe below the outlet, it is 36 feet.

Mr. DEACON: Do you have any deposit in the cast-iron pipes which have to be flushed out by special means?

Mr. THOMS: Provision is made at the bottom of the syphon pipe to flush them.

Mr. DEACON: Is it necessary to use that?

Mr. THOMS: Yes. With occasional flushing the syphon is found to answer extremely well. As to the main outlet, which has a fall of 1 in 1760, or 1 yard in a mile, there is a deposit, but it is carried away by the storm-water, and is self-flushing. Mr. Newton's question is as to wide surface irrigation. There are two reasons why wide surface drainage does not answer. The first is,

as I have shown in the paper, that we have only a third or a fourth of the land we ought to have for the purpose of dealing with the immense quantity of sewage sent down from the town. The second question is replied to in the report of the Borough Analyst which I have embodied in my paper. The sewage contains a large quantity of matters in solution, the nature of which will be understood by reference to the Borough Analyst's report. I may reply that the system of wide surface irrigation does not answer, because of the insufficient area of land at our disposal, and also on account of the composition of the sewage. I might here deal with Mr. Jones's question, as following very naturally that of Mr. Newton, but I don't think I can say any more than I have said already.

Mr. JONES: The same reply will satisfy my question.

Mr. THOMS: Mr. Pritchard and Mr. Jones alluded to the question of interest on capital outlay. Of the money you see put down in my paper as the total cost of our scheme—108,000*l.*—30,000*l.* has been borrowed at 4 per cent. as a perpetual mortgage on the farm.

Mr. JONES: There is no capital repaid?

Mr. THOMS: That will never be paid off. It is a perpetual mortgage of 30,000*l.*, borrowed under a special clause in the Local Act. The residue of the capital has been borrowed for the purpose of making the sewers and other works on the farm. That is borrowed on terminable annuities, the capital and interest repayable in thirty equal annual instalments, at about 6½ per cent. on the original money borrowed, amounting to 4900*l.* per year, for thirty years. That is, the capital and interest in thirty annual payments of that amount will all be paid off. As to the profits on the farm, these are calculated in this manner. We cultivate a certain area of land, and I allow a sum of 2*l.* 10*s.* per acre as a fair price for rental. Then I allow for working expenses and interest at 4 per cent. on working capital, not interest on the money for the purchase of the farm, or for the outlet works for bringing the sewage from the town to the farm. If we take the interest on the capital expended in the purchase of the farm and on the works at the farm into our consideration, there would be a loss of something under 1000*l.* per year.

Mr. DEACON: But you must have sewers; you need not include the cost of the sewers at all.

Mr. THOMS: I think the results are calculated upon a fair basis. With respect to Mr. Pritchard's question as to ventilation. The

ventilation of the main sewers is open to the streets through openings in the man-hole covers. As to the house drainage, that is specially provided for in our Local Act. There complete provision is made. We require all soil pipes to be ventilated, and every wing drain to be ventilated.

Mr. PRITCHARD : That means open ventilation.

Mr. THOMS : Yes, above the eaves of the houses. Next I come to Mr. Kenworthy's question as to the rainfall. Provision is made for receiving a certain quantity of rainfall into the main sewers. By overflows into the brook course, only a portion of the rainfall reaches the farm. But even that is a serious item, because we have to deluge our crops and do serious injury in many ways rather than let it go into the brook course. I think the best system would be that which is known as the separate system, and that this is just such a town as would be well suited by the application of that system.

Mr. KENWORTHY : But you have had no complaints as to the overflow?

Mr. THOMS : Not that I am aware of. In one case of overflow we have to allow the tenant of the land on which our overflow goes the privilege of using our sewage at any time of the year when he wants it without payment.

The CHAIRMAN said, he was sure they were all very much obliged to Mr. Thoms for his paper, and for the explicit answers he had given to the questions put.

Samples of sewage from the Corporation farm, in its various stages of filtration, were then exhibited and explained by Mr. Thoms.

Mr. JONES said, a council would shortly be held, at which would be discussed the question of the Bye-laws. It was very important that they should know what course the various Local Boards were adopting. He believed the Model Bye-laws were sent to all the Local Boards in the kingdom, and he sent out a circular asking what could be done, but he had received very few replies. Mr. Angell had replied that his Board were adopting the Model Bye-laws subject to the Local Government Board fixing the fees. The question did not affect the larger corporations, but it affected the small ones and Local Boards. He had no doubt they would in the end adopt a similar scheme to the Stratford scheme, and fix the fees something like those of the Metropolitan Board

in London. He should think that in another week or ten days the members of Council would receive a circular calling a meeting.

After a little discussion relative to the printing of the Proceedings of the Association,

The CHAIRMAN said he had great pleasure in announcing the formation of another district down in his part of the country, Mr. Boulnois, of Exeter, being the Secretary. That gentleman, he was sure, would be pleased to see any members from this district present at the next meeting of his Committee.

This concluded the proceedings in the Council Chamber, and the members then proceeded on a visit to the Corporation Waterworks at Tettenhall, and the Sewage Farm at Barnhurst.

THE CORPORATION WATERWORKS AT TETTENHALL.

The members and friends were conveyed in brakes from the Town Hall to the Waterworks Pumping Station at Tettenhall, which stands in an elevated position some two and a half miles from the centre of the town. On the bank of the reservoir they were met by Mr. LYONS WRIGHT, the Borough Waterworks Engineer, who gave the following explanation:—

Our source of water is at Cosford, a distance from here of seven miles. At that place we pump the water yielded by a 24-inch bore hole, and also from the river Worf, a tributary of the river Severn, in about equal proportions. This water is pumped into the Tettenhall reservoir, from which it is again pumped into the town by the engines at Tettenhall. There is a reservoir at Goldthorn Hill, the highest part of the borough, which acts as a surface reservoir, the town being supplied from the rising main, and the balance going into the reservoir at Goldthorn Hill. The depth of the bore hole at Cosford is between 900 and 1000 feet. About half of it is 24 inches in diameter, and the remainder 15 inches. The bore hole is in the new red sandstone, then the conglomerates, then the calcareous breccia, which in this position was of the unusual depth of 100 feet. In the conglomerates there was a parting of marly rock about 30 feet thick and perfectly impervious to water. We left off boring in the lower soft red sandstone, a rock very full of water, but not giving much additional artesian force. The water rising from the well is a little over 800,000 gallons a day at the pumping level. The water of the river is admitted to mix with the bore-hole water, in such quantity as is required to complete the whole supply, by an

automatic regulating valve, so that no more of the river water is used than is absolutely required, the whole of the bore-hole water being first used. We have had an artesian well 100 yards in depth from the time of the construction of the works, with a 10-inch hole for a certain distance, and then 7-inch. That has been delivering 140,000 gallons a day for some years past. Arrived at Tettenhall the water rises in the bottom of the reservoir, and thence passes under where we are standing, through strainers, to the engines, which pump it from here through the town to Goldthorn Hill.

A MEMBER: Is the river water sufficiently pure at all seasons to admit of its being used?

Another MEMBER: Where is the river water taken from?

Mr. WRIGHT: From the Worf, a tributary of the Severn, which runs into the Severn at Bridgnorth. The water in the river is very nearly of the same quality upon analysis as the well water: it is entirely supplied by springs. There are a good many springs about on the upper Worf in dry weather. No doubt after heavy rains it softens much, but after there have been heavy rains there is a large quantity of water in the river, and then because it is dirty we pump slowly. There is no town upon the upper Worf of any size—there are a few farmhouses, and we watch them carefully, making periodical visitations to keep the sewage from the fold yards, privies, &c., from the river.

A MEMBER: Is there no sheep-washing?

Mr. WRIGHT: Not on our river. The worst things are some large pools, which Dr. Ballard said grew a great deal of impurity in the shape of rushes. The river is some 10 or 15 feet below the Tettenhall engines. There is much of the town that could be supplied by gravitation if necessary, but we supply it by pumping. The average daily consumption is 2,000,000 gallons; average per head, 18.

After a few more observations from Mr. Wright, the company adjourned to the adjacent engine-house to see the pumping machinery, being accompanied by Mr. Wright, who again kindly gave the necessary explanations. The largest engine is a Cornish engine, and pumps the water from the Tettenhall reservoir. In the same building are two small bull engines, one of which is a "stand-by," to be used when the larger one is stopped for cleaning or repairs; the other one being used to pump the water from a well beneath, which well is exhausted by six hours' pumping every day.

The company afterwards inspected the boiler-rooms, and various desultory questions as to the consumption of coal, &c., were put to and answered by Mr. Wright.

THE CORPORATION SEWAGE FARM.

Leaving Tettenhall, the party re-entered the vehicles, and were conveyed to the Barnhurst Sewage Farm, the nature and peculiarities of which were fully explained in the paper read by Mr. Thoms, and discussed at the morning meeting. Mr. Thoms, who was present, pointed out everything of interest, and the valuable nature of the information imparted was fully appreciated by all the visitors.

THE DINNER.

After thoroughly inspecting the farm, the company returned to Wolverhampton and dined together at the Star and Garter Hotel. The Mayor of Wolverhampton, Mr. D. Kendrick, presided. After the loyal toasts had been given by the Chairman,

Mr. ASHMEAD, the President of the Association, gave the toast of the "Municipal Corporations of the Country." He said he thought they were all well aware of the importance of these institutions, and that they could not do very well without them. Some of those present at all events were very intimately associated with municipal corporations, and for his own part, he could speak from a long service with the Bristol Corporation, extending over twenty-seven years. He thought that very well both for the Corporation and for the Surveyor.

The MAYOR, in responding, said that the municipal corporations of England were of such an extensive character, that he felt somewhat at sea to know how to do the toast the justice which it deserved, and he therefore thought he must confine himself to the lesser responsibility of expressing his acknowledgment on behalf of the Corporation which he represented. As far as his own experience went since he had held his present responsible post, it had always been gratifying and consoling to him to find that the officers connected with the Corporation were always ready to render him assistance to any extent which he might require. This being the case his office was a very easy and a very pleasant one indeed. He congratulated the Members of the Midland District Association upon that day's meeting, for he regarded their Association as one highly deserving of the appreciation of all the corporations of England. He believed that they would really and truly be very

badly off but for such Associations, whose object was to bring about improvements conducive to the health and beneficial to the social condition of the people. He had had a very short acquaintance with their Association, but he found that in its ranks were some of the most intelligent and enlightened men of the day; and although it was a young Association he doubted not that it had a brilliant future before it. He was sorry he had been unable to attend their morning meeting. He had meant to be present, because he should have greatly enjoyed hearing the papers which were read, and which he was fully convinced contained much instruction. As Mayor of the borough, he congratulated the District Committee on having met in Wolverhampton. He begged to give them a hearty welcome, and he hoped that the town might be favoured with their presence another year. He trusted the Association might year by year become more prosperous, for he was sure that its prosperity would be an advantage not only to this district, and not only to municipal corporations, but also to the counties and to the whole of the country. His Worship concluded by proposing the toast of the "Association of Municipal and Sanitary Engineers and Surveyors," coupling with the toast the name of Mr. Jones.

Mr. JONES, in responding, said he felt extremely gratified to the Mayor for the kind manner in which he had referred to their Association. One of the great features in connection with their Association was the fact that it brought together members of a great profession who had hitherto been strangers to each other. The necessity for such introductions was in fact the origin of the Society. For many years sanitary engineers and surveyors had been working, comparatively speaking, in the dark. Each one did not know what his next-door neighbour in fact was doing, and so they were groping their way, each following the bent of his own sweet will, sometimes right and sometimes wrong, but with little help from their surroundings. The consequence was, no doubt, that many of their works were inefficient, or at any rate were not marked by the skill which might have been shown had their constructors rubbed shoulders one with another, as they might have done, and so gathered those hints and helps from each other which, as impartial men, they were all happy to give and to receive. That state of things to which he had been alluding had all passed by; and he could say that he had derived more benefit during the last four years from the associations he had made, the friendships he had formed, and the help he had received in connection with the

Society than he had in the previous twenty-five years during which he had been engaged in sanitary work. From this point, and he took it as one of the highest points in connection with the Association, he was glad the Association had been formed, and that it had been based upon the principles of self-help. He quite appreciated the Mayor's idea that the work which was being carried out by those who were the servants of the municipal corporations and local boards were of no mean order. It was a work which had to do with the moral prosperity of the world, and was lifting it out of the mud of ignorance, and almost of superstition, into which it had fallen, and elevating it to the high platform of science. In connection with these sanitary matters much had been said about dirt, but hitherto people had been grovelling in much worse dirt, the dirt of ignorance, which was the worse dirt of all. Through the mud and dirt of their sewage farms, however, much was now being found out. Their medical officers and their municipal corporations, and their great men both in and out of the Houses of Parliament, were turning their attention to these points, which were so peculiarly at the present time points of interest. He said, with deference to other societies, that none had a work more calculated to bring about the well-being of all than the work that the surveyors of the municipal corporations and local boards had to carry out. Not to multiply words, he would briefly say he was glad they had met in Wolverhampton. That was his first visit to the town, as no doubt it was the first of many others in that room. They had met with a most hearty reception, and had witnessed a gathering which was a credit to the Secretary of the Midland Counties District. He trusted they might have many such meetings, and that on some future occasion they might again have the presence of the Chairman of that evening. Perhaps in the course of another year or two they might come to Wolverhampton again, and they would then be pleased to see not only the Mayor but also other members of the Council who were interested in sanitary matters present with them. He begged to express the thanks of the Members to his (the Mayor's) esteemed servant for having given them so much information and instruction respecting the sewage farm. That information had been of an extremely valuable character, and reflected the highest credit upon Mr. Thoms as the Corporation Engineer, and also upon the Municipal Corporation of Wolverhampton, who were supporting him in the great work which he had undertaken.

Mr. DEACON, who was received with applause, said that he

thought he ought to preface his remarks by a quotation which a witty novelist had put in the mouth of a certain old woman, "He says it as shouldn't," for he thought it would be difficult to find any body of men who might more fairly say to themselves that their duties were of a responsible nature than the gentlemen belonging to that Association. He thought also that they would not be charged with too great egotism, if in the presence of any of those gentlemen whom they immediately served, and through whom they served their country, they should express their sentiments in that respect, for he was satisfied that if they did not each of them believe that they held responsible positions, they would not give to those positions the thought which was necessary to success. It had devolved upon him to propose the toast of the Mayor of Wolverhampton; in doing so, he felt he was asking the company to drink the health of a gentleman who represented a town which had at heart the most perfect fulfilment of the ends towards which their duties pointed. Speaking generally, they could say that of all the municipal corporations of this country, but certainly in different degrees, and judging from what they had seen that day, they could not, he thought, fail to be satisfied that the Corporation of Wolverhampton was setting its face, and its discussions, and its decisions, in the right direction in sanitary matters.

The toast was enthusiastically honoured.

The MAYOR, in responding, said that to hear his health given at a meeting of Members of such an Association made him feel elevated above his ordinary municipal calling. Mayors, as they well knew, had many municipal children to nurse. In Wolverhampton they had their streets, their waterworks, and their park scheme, and several other projected works of improvement. There were also several other children to nurse, but he thought none of them required so much attention as those of a sanitary class. These required, he must admit, a great amount of care and anxiety, but when they had an engineer so well up in the duties as was Mr. Thoms, the minds of the municipal authorities might be set tolerably at rest as to the welfare of their bantlings. He knew that such a meeting as they had held that day must be a great assistance to their Borough Engineer, for, however much he might know, he could still learn more from such a gathering and from his connection with the Association.

Mr. PRITCHARD next said that the toast he had to propose was

one which gave him infinite pleasure. It was the health of Mr. Thoms, the Borough Engineer. Although Mr. Thoms was a recent addition to their Association, judging from what they had seen of him that day, he was a very promising Member, who would be making his mark amongst them. As the Secretary for the Midland District, to which fact allusion had been so kindly made by the General Secretary, Mr. Jones, he (the speaker) felt that in organizing a meeting of their Members, much depended upon the assistance given by each individual Member, and in that respect he had everything to be thankful for. He could assure them that in the present instance every assistance that was possible to be given had been given by Mr. Thoms. At a very short notice he called upon Mr. Thoms to make provision for their reception in Wolverhampton. That gentleman responded most heartily. He was perfectly satisfied in knowing that he had a duty to perform, and he thought the Members would agree with him in saying that he had ably performed it. The compliment paid by Mr. Jones was well deserved. The paper submitted that day was a very good one, and that he felt satisfied they would all agree in thinking contributed certain information with respect to sanitary matters in that part of the district which was very interesting. The works that they had seen that day, not forgetting Mr. Thoms's able predecessor, a gentleman he had been personally acquainted with, appeared to have passed into the hands of one who was thoroughly able to manage them. That augured well for the prosperity of sanitary matters in the borough of Wolverhampton. He took that opportunity of thanking Mr. Thoms for what he had done on behalf of the District Committee, and at the same time of proposing his health, and expressing a hope that he might long live to be a Member of that Association.

Mr. THOMS, who was much applauded on rising, replied in a brief manner, simply expressing his thanks for the kind and cordial reception of his name, and his pleasure that what little he had done had met with the satisfaction of the Members.

Mr. JONES next proposed the health of Mr. Lyons Wright. He said that on visiting the Waterworks that afternoon, the company were met by that gentleman, and as General Secretary of the Association, he (Mr. Jones) took that opportunity of expressing their thanks. Mr. Wright had so courteously received them, and had given them much valuable information in the most willing and gentlemanly manner, that he thought it was only due

that an expression of thanks should come from one representing not only the Midland District, but the whole of the Association.

Mr. WRIGHT said he was glad that anything he had done had been of any service, and he regretted exceedingly that time did not allowed the Members of the Association to visit the whole of the waterworks belonging to the Corporation, especially that they were prevented from visiting that more important part of the waterworks which lay farther afield.

The toast of the Press having been honoured and responded to by the representatives present,

Mr. THOMS proposed the health of the Vice-Presidents of the Association, referring particularly to the debt which he owed to one of them, Mr. Deacon, for the instruction imparted to him when in that gentleman's office. He was a man who had invented improvements of all kinds in connection with tramways, waste of water—which was a matter of vital importance to all corporations—and other sanitary works. He was a man of whose presence amongst the Members of that Association they might well feel proud.

Mr. DEACON and Mr. PRITCHARD having each briefly responded, the proceedings terminated.

DISTRICT MEETING AT SOUTHPORT.

THE Eighth Meeting of the Lancashire and Cheshire District Committee of the Association of Municipal Surveyors was held, by the kind permission of the Mayor, at the Town Hall, Southport, on Friday, 24 May, 1878.

There were present F. Ashmead, President; J. Lemon, Past President; G. F. Deacon, E. Pritchard, A. W. Morant, Vice-Presidents; T. C. Thorburn, Birkenhead; J. Loble, Hanley; J. T. Lea, Wallasey; W. Battin, Aston Manor, Birmingham; J. Cartwright, Bury; J. Mitchell, Hyde; W. H. Wheeler, Boston; J. Proctor, Bolton; J. H. Smethurst, Sowerby Bridge; J. Wilson, Bacup; J. M. Jones, Chester; A. G. McBeath, Sale; J. Banks, Kendal; E. Knowles, Accrington; R. Vawser, District Secretary; — Elsley, Bebbington; G. Biddle, Bootle; J. H. Burton, Audenshaw; T. Sunderland, Blackpool; H. Royle, Stretford; T. Longden, Warrington.

The Minutes of the last Meeting were read and confirmed.

On the motion of Mr. Pritchard, seconded by Mr. Lemon, R. Vawser was re-elected District Secretary, subject to his being qualified by the Council of the Association, he having become disqualified as a Member according to the Rules of the Association.

The following paper, compiled by Mr. W. Crabtree, Borough Surveyor, on the Main Sewerage of Southport, was then read by the Secretary, Mr. Crabtree being unfortunately absent in London on the business of the Corporation.

DESCRIPTION OF THE MAIN OUTFALL SEWER OF THE BOROUGH OF SOUTHPORT.

BY W. CRABTREE, Assoc. Inst. C.E., BOROUGH SURVEYOR,
SOUTHPORT.

SOUTHPORT is a modern town, of remarkably rapid growth. Local government was inaugurated by the Southport Improvement Act in 1846, when the population was about 4000; in 1861 the census returns give a population of 8940; in 1871, 18,086; and at present date by computation the population is about 32,000.

There were	234	inhabited houses in	1831
"	592	"	1841
"	1007	"	1851
"	1439	"	1861
"	3326	"	1871
"	6018	"	1878

700 houses were added by the incorporation of 1875.

The sewerage of the town has never been entirely neglected, but was extended on rather a temporary scale as building operation increased the area to be drained. Before the new intercepting sewer was begun, there were 26 miles of main sewers within the borough, varying from 12 inches to 3 feet diameter, having two outlets on to the shore, about three-quarters of a mile from the Promenade, and two outlets into Fine Jane's Brook, which forms the boundary inland, and empties into the sea at Crossens Channel.

Several schemes during the last twenty-five years have been before the authorities.

In 1853 Mr. Newlands, the late Borough Engineer of Liverpool, recommended a main sewer in Lord Street, into which all the side streets abutting on Lord Street should fall, and a pumping station in the neighbourhood of Hill Street to lift the sewage to a higher level, then to fall inland into Fine Jane's Brook by gravitation.

In 1862 the Scarisbrook trustees constructed a deep sewer in Duke Street, emptying into Fine Jane's Brook, which received all the sewers from Derby Road and Windsor Road on the east and west as far as Upper King Street. This opened out a large area of building land from Princes Street to Ecclesfield.

In 1870 the writer, at the request of the Council, reported on

the feasibility of conveying the sewage to Crossens Channel with a reservoir on the shore, north of Hesketh Park, to be filled at high tide for flushing the sewer at low tide, with a suggestion as to the enclosure of 200 acres of the Marsh Land near Crossens for irrigating purposes, but nothing came of it.

In the Southport Improvement Act, 1871, a clause was inserted that certain improvements were not to be carried out until a "report on the sewerage of the borough should have been obtained from some eminent engineer;" and in August, 1871, Messrs. Lawson and Mansergh, Engineers, of Westminster, were instructed to report on the "Mode of Sewering and Draining the Borough." They furnished a most able and exhaustive report, describing all the various systems of disposal of sewage that had been tried with any degree of success, concluding with a recommendation "to remove all sewage from the sands in front of the town," to sewer all the Borough to the Duke Street outlet, from there to pump the sewage to land in Ainsdale—2½ miles from our boundary—and utilize it on a 220 acres of land, with a similar quantity to be secured for future extension.

Difficulties with the landowner prevented this being carried out. When first mooted, he was inclined to grant a lease, but ultimately refused, saying "it would probably soon be surrounded with good villas, or itself be required for building land before long."

In November, 1871, Mr. T. D. Barry recommended a scheme for sewerage the borough to Crossens Channel, and cutting a new channel across the bank for three quarters of a mile into the Cockle Lake, to divert the sewage and fresh water in the direction of Lytham, to avoid polluting the stream that passes near the end of the pier. This was found to be impracticable. If the channel could ever be cut eight or nine feet deep, at any tolerable expense, through a bank covered twice each day by the tide, there was every probability that the tidal currents would have little regard for it; and the keeping of it open would be attended with constant and serious outlay, as recent surveys, compared with the Admiralty charts, indicated considerable alteration in the courses of the channel within the last few years. This scheme was not entertained.

In the same month Messrs. Lawson and Mansergh were requested to report "as to the feasibility and cost of conveying the sewage by an outfall into the tidal stream at a point three quarters of a mile from Crossens, or at any other point in the direction of the sea."

This report was elaborately prepared, comparing the suggested outlet in the Southport Channel, three quarters of a mile from the promenade, with one at Crossens, half a mile from the village of Crossens, concluding with the remark: "We should have preferred to any scheme for discharging the sewage into the sea one for utilizing it by supplying it to land; but as we are informed by you that there are serious objections to the carrying out of the plan suggested by us in a former report, we beg to recommend, as the next best mode of effectually disposing of the sewage, the construction of the outfall at Crossens sluice channel, especially as this scheme will admit of the sewage being utilized at any future time if thought necessary or desirable."

In July, 1873, the Borough Surveyor was requested to report on each of the three suggested outlets—viz., Southport Channel, at Dutton's Lake; Fine Jane's Brook, at Crowlands; and Crossens sluice channel, also on a pumping-station at Marshside, north of the boundary of the borough. This report furnished the levels of the principal streets in the town, and showed the impossibility of any scheme of sewerage being practicable with gradients that would be self-cleansing for their entire length at any of the suggested outlets, and hinted at pumping as the safest measure for effectually providing self-cleansing sewers, or ample provision for flushing and constant attention thereto. (The level of the highest street in the town is only 29 feet above Ordnance datum or mean level of the sea; the lowest is only 16 feet; and the length of the borough fronting the sea is four miles.) This report was very ably discussed in the "Southport Visitor," by "Junius," in favour of pumping at Crowlands on to land bounded by three brooks; to be dealt with on the principle of intermittent filtration.

In order to ascertain whether sewage discharged at the proposed outlet would be liable to be carried up the channel to Crossens sluices, flat wood floats, legibly marked on the top, "Five shillings will be given to any one bringing these floats to the Town Hall, Southport," were put in the channel on three successive days, at intervals of one, two, and three hours before low water; and out of nine floats so placed one only returned into a creek adjoining Crossens sluice channel, the others have not been heard of.

In the meantime Mr. Lawson died, and Mr. Mansergh was instructed "to report fully and independently on the whole question." This comprehensive and masterly report, of July, 1874, recom-

mending the present scheme, was adopted by the Council, and Parliamentary powers were obtained in 1875. Contracts were let, and the work commenced in March, 1876. The nature of the ground admits of but little gradient. The invert of the old Duke Street sewer, which the new one had to intercept, was only 10·39 feet above Ordnance datum, the bed of the channel at the outlet only 4 feet above Ordnance datum, so there is 6·39 fall for a distance of 22,250 feet.

Crossens channel is the outlet for the drainage of about 36,000 acres of land, the dry weather flow is about twenty times the bulk of the sewage to be discharged there; the end of the sewer is 800 yards from the nearest house at Crossens, the length of the channel as it detours from the outlet to the pier-head is $7\frac{1}{2}$ miles. As the sewage can only be discharged when the tide has receded below the invert of the sewer, it will be met by the incoming tide before reaching within a mile of the pier-head or a mile and a quarter from the bathing ground.

The invert is fixed at 4 feet above Ordnance datum, consequently high water of neap tides (10 feet, which is 5 feet above Ordnance datum) is only 1 foot above the invert of sewer outlet. High water of spring tides (21 feet, which is 16 feet above Ordnance datum) will be 8 feet above the top of the outlet. The high tides are every 12 hours and 20 minutes; so the time of rising and receding is practically the same for any tide that may be above the top of the pipe, but of the 710 tides in the year there are 175 that will not reach the higher tidal valve; the outlet is divided into two lower and two upper loosely hung self-acting tidal valves or flaps. Ordinarily only thirty-four tides in a year will be above the top of the salt marsh on the west side of the channel, any deposit that may take place must be in the channel, not on the salt marsh.

The trials that were made with the floats which were sent down before the outlet was determined upon, dispel the idea of any nuisance arising from the fouling of the shore or from any backward flow of the sewage in the Crossens channel, which was a point that most exercised the mind of the Engineer when deciding the site of the outlet that it should be safe from any inconvenience or fouling in the future, of either the shore or the channel. The system adopted is that which has been so successful at Frankfort-on-Maine for a population of over 100,000 inhabitants, by which the contents of the sewers are dammed up at intervals by flushing

gates, to be suddenly opened, thereby increasing the velocity to at least 5 feet per second, commanding the whole intervening length between one flushing gate and another.

The whole of the pipe sewers have Stanford's patent joints, which are more reliable than cement joints in running sand, where it would have been almost impossible to secure good impermeable joints in the ordinary way. The level of the sewers is from 6 to 12 feet below the level of the water in the subsoil, which is coarse sand at the surface, becoming finer as the depth increases, the bottom being oozy silt. In a few places peat moss was cut through, and where this soft black turf formed the bottom, the use of patent joints became more of a necessity, as from their spherical form of joint they allow a slight deflection without damaging the joint, which is not the case with cement.

The outfall is cast-iron pipes, 4 feet diameter, for 477 feet, where there is a tidal flap, and also a penstock at the edge of the marsh grass. There are self-acting tidal valves at the outlet channel. From this point it is a 6 feet by 4 feet egg-shaped sewer of 9 inches brickwork, surrounded with concrete for 7583 feet, and has a gradient of 1 in 5000. This length is provided with 11 flushing gates and a screening chamber with penstock. The next, 4490 feet, is 5 feet by 3 feet 4 inches, with a gradient of 1 in 3000, to the inspection chamber at Park Avenue. In this length there are 7 flushing chambers and 1 penstock. From thence the size is 4 feet by 2 feet 8 inches for 9700 feet, with a gradient of 1 in 3000 to the 3-foot old sewer at Duke Street. This length is provided with 16 flushing gates and 1 penstock. At Marshside Lane there is a branch, 3 feet 6 inches by 2 feet 4 inches for 5125 feet; 3 feet by 2 feet for 4180 feet to Sussex Road old sewer, provided with 7 flushing gates, then 21-inch pipes for 3573 feet up to Meolscop Road, and 12-inch pipes for 424 feet. The pipe sewers are provided with 8 penstocks for flushing.

At Park Crescent is another branch, 3 feet by 2 feet for 6074 feet to Nevill Street, provided with 9 flushing gates and 1 penstock; 21-inch pipes from Nevill Street to Eastbank Street for 830 feet; 18-inch pipes for 805 feet to Portland Street; 15-inch pipes for 820 feet, to Duke Street; 12-inch pipes for 740 feet, to the boundary of the borough at Birkdale. There is a 15-inch branch sewer in Leicester Street for 828 feet; a 15-inch sewer in Nevill Street for 430 feet, and a 9-inch pipe for 548 feet to the

Baths. There is also a 15-inch branch in Eastbank Street for 1645 feet.

These pipe sewers are all provided with penstocks for flushing—six in number.

The total length of sewers is 9 miles 1401 yards.¹

The flushing gates or penstocks are 200 yards apart. There are three ventilators between each flushing gate, making the ventilators about 50 yards apart, throughout the entire length open to the surface.

The Nevill Street sewer is flushed from the Baths, which have one bath containing 65,840 gallons, two of 50,000 each, one of 55,228, one of 45,668, one of 40,608, two of 28,000 each, or a total of 332,000 gallons, which in the summer season are emptied every night, and in winter twice per week. Flushing is also provided at the Hesketh Park Lake and at the Old Pool. There is also an overflow at the pool. Storm overflows are provided at Duke Street, Nevill Street, Scarisbrick New Road, and two in Butt's Lane.

The time occupied by the sewage in traversing from the various extreme distances is:—

	Hrs.	Mins.
From Upper Buke Street	7	12
„ Scarisbrick New Road (upper end)	6	
„ Park Road	5	34

The whole of the sewers are not yet connected with the new outfall, but from a trial by floats on the 21st May, there can be no question of the flushing arrangements, if regularly attended to, keeping the sewer free from deposit. On the following page is a table of the rate of flow, and the distance the velocity is effected; from which it appears that in the 5 feet by 3 feet 4 inch brick sewer with stop gates, 4 feet high from the invert, 5 feet per second can be attained for 200 yards, 4 feet per second for another 200, and 2 feet per second at a distance of 1500 yards from the flushing gate. This trial was made between 3 and 4 o'clock, when it was high tide at 2.50 at Southport, when the efficiency of the self-acting tidal valves was shown to be all that could be desired. If they had failed, the tide would have been within a foot of the top of the flushing gate at the inspection chamber. It should be stated that the water was 9 inches deep behind the flushing gate, and 3 feet 9 inches deep in front; that the first float traversed the 540 feet in 11½ minutes, or only 9½ inches per second, a quarter of an hour before the flushing gate was opened.

BOROUGH OF SOUTHPORT.

EXPERIMENTS WITH FLOATS FROM THE INSPECTION CHAMBER, MAY 21st, 1878.

Heads—3 feet 9 inches front; 9 feet back; 3 feet head of water on gate.

Flushing gate opened at 3 hours 17 minutes.

No.		Inspection Chamber.			1st Flush Chamber.			Time.	Velocity per Second.
		hrs.	min.	sec.	hrs.	min.	sec.	sec.	feet.
1		3	17	0	3	18	50	5	110
2	Paper boats	3	20	30	3	24	10	2½	220
3		3	22	20	3	26	10	2·3	230
1		3	26	50	3	29	50	3	180
2	Wood floats	3	27	30	3	31	80	2½	240
3		3	29	35	3	33	25	2·35	230
	Distance	0			540 feet				

No.		2nd Flush Chamber.			Time.	Velocity per Second.	Marsh-side Lane.			Time.	Velocity per Second.
		hrs.	min.	sec.	sec.	feet.	hrs.	min.	sec.	sec.	feet.
1		3	21	20	150	4	3	57	18	1·51	2155
2	Paper boats	3	28	10	240	2½					
3		3	31	30	320	1·88	3	59	30	1·95	1680
1		3	34	40	290	2·07					
2	Wood floats	3	36	40	310	1·94	4	6	30	1·82	1790
3		3	38	30	305	1·25					
	Distance	1140				4500 feet					

The theoretical velocity is 13 inches per second, but for 3 feet head at the flushing gate the average velocity for 543 feet equalled 5 feet per second for 1 minute 50 seconds.

PAPER FLOAT.

After 3 minutes flow equalled 2½ per second for 7·10

" 5½ " " 2½ " 9·10

WOOD FLOAT.

After 9 5-6 minutes flow equalled 3 per second for 12·50

" 10½ " " 2½ " 14½

" 12 35 " " 2 35 " 16·25

At 1140 feet from the flushing valve the average velocity for the latter 600 feet—

PAPER BOATS.

4 minutes 20 seconds after valve was lifted was 4 feet per second

11 " 10 " " 2½ "

14 " 30 " " 1·88 "

WOOD FLOATS.

17 minutes 40 seconds after valve was lifted was 2·07 feet per second

19 " 40 " " 1·94 "

21 " 30 " " 1·96 "

DEDUCTION.—After 20 minutes from lifting the flushing valve the force is expended at 400 yards to the lowest limit for self-

cleansing, but only slightly affected for 1100 yards further. As there are flushing appliances at every 200 yards, the effect beyond that distance is not of much importance.

COST.

The total cost of the sewer is.. .. . 102,852

The chief items are cast-iron pipes on Salt Marsh, 150 yards, 7 feet to	
12 feet deep	1,647
Greenheart piles and works at outlet	519
6' 0" x 4' 0" brick sewer 12 feet to 15 feet deep, 1971 yards	16,244
Screening chamber, penstock and tidal flap chamber	825
9 flushing chambers, on 6' 0" x 4' 0" brick sewer	704
33 ventilators, on 6' 0" x 4' 0" brick sewer	195
5' 0" x 3' 4" sewer, from 15 feet to 22 feet deep, 1442 yards	9,753
6 flushing chambers, on 5' 0" x 3' 4"	520
5 manholes, on 5' 0" x 3' 4"	88
1 penstock chamber, 5' 0" x 3' 4"	66
Inspector chamber	530
22 ventilators	172
Sand hills, removing, 29,920 cubic yards	1,870
Timber left in trenches	9,914
4' 0" x 2' 8" brick sewer, 3160 yards, 18 feet deep	18,971
12 flushing gates, on 4' 0" x 2' 8"	793
11 manholes, on 4' 0" x 2' 8"	343
29 ventilators, on 4' 0" x 2' 8"	190
3' 6" x 2' 4" brick sewer, 13 to 15 feet deep, 1642 yards	5,551
3' 0" x 2' 0" brick sewer, 9 to 20 feet deep, 3418 yards	12,601
11 flushing chambers, on 3' 6" x 2' 4", sewer	264
4 manholes, on 3' 6" x 2' 4", sewer	76
16 flushing chambers, on 3' 0" x 2' 0"	607
44 ventilators, on 3' 0" x 2' 0"	201
21-inch pipe sewers	2,012
15 manholes, on pipes	185
16 ventilators, on pipes	113
8 flushing gates, on pipes	123
1476 yards of 21-inch pipes, with Stanford patent joints, 7 feet to 10 feet deep	2,009
419 yards of 18-inch pipes with Stanford's patent joints, 6 feet deep	537
1335 yards of 15-inch pipes, with Stanford's patent joints, 5 feet to 9 feet deep	1,315
284 yards of 12-inch pipes, with Stanford's patent joints, 5 feet to 14 feet deep	237

The steam navvy at Hesketh Bank having been visited, in the absence of Mr. Barnes, Contractor of the Railway, Mr. P. Thursby, Resident Engineer, explained its details, and since the Meeting the explanation has been reduced to writing.

REPORT UPON THE EXCAVATING MACHINE, OR STEAM NAVVY, IN HESKETH BANK CUTTING.

By P. THURSBY, RESIDENT ENGINEER.

THE cutting is composed throughout of a stiff brown clay, free from any large stones; and is believed to be the first hard clay cutting in England in which a steam navvy has been used, although previous to its adoption in this instance, there have been several instances of its being successfully worked in sand, silt, loose shale, or soft free clay.

The steam navvy was manufactured by Messrs. Rushton, Proctor, and Co., of Lincoln, and consists of a rectangular truck supported by four wheels carrying the engine and boiler, wheel gear, fixed post and jib; the engine is of the vertical type, of 10 H.P. (two cylinders), and gives motion by a pinion upon its crank shaft to the main spur wheel upon the main hoisting drum shaft, from which the motion is communicated to the drum for swinging the jib, and the drum for drawing the bucket back; the drum for swinging the jib has a reversing motion for swinging both ways; the bucket handle is regulated by a hand wheel and chain pinion, which gives motion to a pinion at the top of the jib gearing into a rack, placed upon the bucket handle. The truck is provided with six strong screws, or lifting jacks, for the purpose of steadying, and taking the whole weight of the navvy when at work. The jib, which carries the bucket handle, is entirely constructed of plate and angle iron, as also is the fixed post and truck; at the bottom of the fixed post is a water tank for supplying the boiler. The bucket is constructed of plate iron, and is fitted with four steel pointed teeth, also with a sharp steel nose, where it first comes in contact with the ground. It is also fitted with improved propelling gear, for moving the machine along the rails by means of a self-acting arrangement of reversing tooth gear, which communicates the motion to the front axle by an endless chain. A corrugated iron

roof cover the engine and the whole of the working parts excepting the jib gear.

The dimensions of the cutting excavated are 30 feet base, 2 to 1 slopes, greatest depth 22 feet, smallest depth 12 feet, length about 15 chains, contents about 60,000 cube yards.

The steam navvy is placed upon the formation level of the cutting, on lengths of large flat-bottomed rails, laid upon 12-inch by 6-inch sleepers about 2 feet apart; a tram road for empty wagons follows up the centre line behind the machine; two other tram roads, one on each side of the navvy, parallel to the centre line, are laid at a height of 3 feet above the formation; these are the roads on which the wagons are filled by the machine. This difference of level between the wagons and machine is accounted for by the machine bucket being swung round in either direction through an angle of 90° with the centre line of the railway, with a radius of 18 feet, which necessitates the centres of the wagons being that distance from the centre line of the railway, and at right angles to the jib pillar. The bottom of the cutting being only 30 feet wide, the wagons are raised 3 feet above formation level, where the width is 42 feet.

The empty wagons are brought up the centre road to the back of the steam navvy, then passed alternately to the right and left of the machine, so that whilst the navvy is filling one on the right road, an empty wagon may be placed ready on the left road, and *vice versa*. When the wagons are filled they are passed along their respective roads, to the right or left of the centre line, to the neck of the cutting, and are there disposed of. Two wagons can thus be filled in five minutes, and, barring accidents, there is no reason why this pace should not be maintained throughout the day, with intervals for shifting the machine. The action of the bucket in the clay very much resembles that of a scoop in a Stilton cheese, with the exception that the bucket acts in a somewhat circular direction upwards, taking out of the clay a slice from bottom to top of the cutting; the thickness of the slice, upon which, to a great extent, the proper working of the machine depends, varies from 4 to 6 inches, and is governed by the man at the hand wheel, who controls the rack and pinion of the bucket handle. When the bucket reaches the top of the cutting, the driver draws it up to the jib end, by this means getting the bottom of the bucket in a horizontal plane, turning the jib at the same time, until the bucket hangs over the centre of one of the wagons about to be filled (the

position of which has been previously explained); the man at the wheel then pulls a cord which draws a bolt, fastening the door at the bottom of the bucket, causing the contents to fall into the wagon below; the bucket is jibbed round and at the same time allowed to fall to formation level, bringing the bottom into a vertical position. The door should be so constructed as to shut itself automatically; this motion is, however, not perfect in the machine under consideration, and this has to be accomplished by manual labour. The operation is now repeated, until all clay within reach of the machine is excavated; the navvy is then allowed to take its bearing on the wheels, the jacks being slacked; and it is moved forward by its own powers of locomotion, and a fresh start is made.

The operation of shifting position usually occupies ten minutes, and occurs four or five times in a day. If the cutting averages 16 feet deep, 30 feet formation, and 2 to 1 slope, the advance per diem would be about 12 feet.

The total cost of the machine, fixed and ready for work, is about 1300*l*.

The total cost of the dirt, delivered at the cutting entrance, ready to convey to its destination is 8½*d*. per cubic yard.

The steam navvy does the work of over forty men.

On the return of the Members from Hesketh, they viewed the Main Drainage Works, under the guidance of Mr. Morrow, Resident Engineer, and returned to the Town Hall, where the following discussion ensued.

Mr. LEMON remarked that, after examining the sewer, he thought that for the gradients, &c., every special means had been devised for preventing any deposits in the sewers. With reference to the flushing arrangements, he was of opinion that they were very complete in themselves, and would have their desired effect. The velocity they saw that day was very good, but he was afraid that, in ordinary cases, it would be only 1½ per cent. to the second. That was a very low fall, and was not certain to keep the sewer clean. However, whether the flushing would have the desired effect, of course time only would show. He did not wish to criticise their schemes, but at the same time he must say they were met here for free discussion. He was himself rather opposed to what he considered the principle of reservoir sewers. He thought it was far better to have a sewer suited

for the work it had to do, and devise other means for the work of a reservoir. But if the means adopted here for the sewers would have the desired effect, of course it would be all right. They seemed to be of a reservoir capacity. He was told that, at the present day, the population of Southport was about 32,000, and he should like to know if provision had been made for a further increase in the population. Then they would afterwards be able to judge of the capacity of the sewers. Of course, it was a very large population, but if there was a larger number devised for, then that would alter the case. In reference to what he called the calculated discharge of the sewers, he thought that from what he heard from the reading of the paper that morning it was 800,000 gallons per day; but, in his opinion, that was very much under-estimated. He was quite sure that the quantity was very much over that, but where it rose from he did not know.

Mr. THORBURN remarked that Mr. Lemon had called his attention to the special arrangements in the sewers, and he (the speaker) thought they seemed to be worked very completely indeed, cost, apparently, not being a question at all in the scheme. Southport was an exceptional town, for the population might vary from 30,000 to 50,000 in the season, so that they could not very well, in looking at a scheme like that, say it was for the inhabitants of the place only. The lodging-houses here were very numerous, and anyone going through the town would see there was accommodation for 50,000 or 60,000 people. It was a town depending entirely upon its visitors, and the Southport Corporation have shown good sense in providing a main outfall sewer. Upon the whole he considered the arrangements very complete; but, as they all knew, there were difficulties in removing the silt of sewers in sand. The water should be stirred up, and a special reservoir sent through these sewers. Experience told them that a great rush of water through a long length of sewer very soon lost its effect. There was no doubt that the outlet was 4 feet, which they would find sufficient for the discharge of the sewage they had between low water and high water. He thought on the whole the town of Southport was to be congratulated on carrying out such a complete system.

Mr. JONES said he would like to ask if there was any estimate of the future cost in reference to the carrying out of the flushing system.

Mr. MORROW explained that the sewer was computed for a very

much larger population—at least double. The sewer that morning was backed up, or there would have been a greater flow. With reference to the question of expense, two or three men would be sufficient to look after the sewer, probably two only.

Mr. LEMON proposed, and Mr. THORBURN seconded, that the thanks of the meeting be accorded to Mr. Mansergh, the Engineer, for having placed at the disposal of the Members the elaborate drawings and diagrams of the works, and for his courteous entertainment; also to Mr. Morrow, for his assistance and guidance during the day.

A similar vote was unanimously carried, thanking Mr. Barnes, contractor, for his kindness in specially working the steam navy at Hesketh Bank on the occasion of their visit.

It was then proposed by Mr. Deacon, and unanimously resolved, that the thanks of the Meeting be conveyed to the Mayor and Corporation of Southport, for the use of the Council Chamber for this Meeting.

Votes of thanks to the Chairman and District Secretary followed, after which the Members adjourned to the Prince of Wales Hotel, where dinner was served.

DISTRICT MEETING AT EXETER.

THE Western District Members of the Association held a meeting at the Guildhall, Exeter, on Friday, June 21, 1878. The Right Worshipful the Mayor of Exeter (Mr. Henry Drew Thomas) had placed the Council Chamber at the disposal of the Hon. Secretary of the Western District (Mr. H. Percy Boulnois, M. Inst. C.E., the City Surveyor) for the Meeting, and the Mayor cordially received the Members as they assembled. Mr. F. Ashmead, Bristol, President of the Association, presided, and there were also present, Mr. C. E. Ware, Exeter; Mr. J. H. Smith, Taunton; Mr. G. C. Strawbridge, Taunton; Mr. William Dawson, St. George, Gloucestershire; Mr. Galsworthy, Aldershot; Mr. Robert Hodge, Plymouth; Mr. H. Percy Boulnois, Exeter; Mr. Price, Architect, Bristol; Mr. Churchward, Member of the Aldershot Local Board; Mr. Donald Cameron, Assistant Surveyor to Mr. Boulnois; and Mr. Cole, from Mr. Boulnois' office.

The PRESIDENT: Gentlemen, I must congratulate the Members present, although they are few in number, upon meeting in Exeter for the first time. We have not been very long associated together; this is the first business meeting in the Western District; and I have especially to thank Mr. Boulnois for having undertaken the office of Honorary Secretary. This being the first meeting, then, I may perhaps be permitted to say something of the Association. It is merely the binding together of the different Sanitary Engineers and Surveyors of the Municipal Corporations of the country. In the north we are much more fully represented, the towns being more frequent and larger. In the south we have not, until the present Meeting, had an opportunity of meeting one another. The great advantage of this Meeting is, that the Members derive information from one another, and see what is doing as regards sewerage and other works. As a rule, we are very well supported by the Mayors and Corporations of the different towns which we visit, showing that we are identified with them, and are acting with and for them. The District Meetings are held for the convenience of the Members. The whole country is divided into

four districts, and the Members of each district hold meetings independently of the Annual Meetings of the Association, this being, as I have already said, the first Meeting of the Western District. The Annual Meetings are held alternately, every third year in London, and in the other two years in the large towns. Next month the Annual Meeting will be held in Liverpool ; last year it was in Bristol, and in the previous year in London. The District Meetings, as a rule, we endeavour to hold quarterly. Of course that depends, to some extent, upon the local Secretaries and the Members who can provide papers for discussion. Unless there are interesting papers to offer for discussion, we do not meet. During my year of office I have attended about six District Meetings. The rule now is that within twenty-eight days from the Meeting, the proceedings shall be printed and sent around to all the Members, so that those who cannot attend are kept well informed of what is going on. I do not know that I need detain you with any further remarks, except in the name of the Association to thank the Mayor of Exeter for attending, and for having given us the use of the Council Chamber on the present occasion.

Mr. BOULNOIS expressed his regret that the Meeting was not so large as had been anticipated. Notice had been sent to all the district Members of the Association, but several of them were in Paris, and Exeter lay so far to the west that many others were unable to attend. He introduced the Members present, and the visitors from Bristol, Aldershot, and Exeter.

The MAYOR : I am sorry that my many engagements prevent me from hearing the paper that Mr. Boulnois is about to read, and from joining you in your trip down the canal. I hope that you will have a pleasant meeting, and that it will result in your being enabled to gain from each other the information which each possesses, to the advantage of yourselves and of the municipalities which you represent. On behalf of the city I am always pleased to receive the members of any association that is joined together for the purpose of improving the sanitary condition of the country at large. I hope the result of your deliberations will be, that we may be the better enabled by-and-by to discover the best means of getting rid of our sewage, and also the best means of supplying our cities with water from a non-contaminated source. If you do this, you will do a very good service, and this city, among others, will be benefited by the result of your deliberations.

THE EXETER CANAL.

By MR. H. PERCY BOULNOIS, M. INST. C.E.

THE Exeter Canal is the earliest ever constructed in this country, although others may have previously existed in China, and perhaps Holland. It has, however, gone through much alteration, and many improvements have been made to it since its commencement. Before the year 1260 the tide came up to Exeter, and the river Exe was navigable for barges up to and perhaps beyond that point. It appears, however, that unfortunate differences and disputes arose between the citizens of Exeter and the Earls of Devon, and the latter, in order to annoy the citizens and stop their trade, constructed weirs and dams across the river, and completely destroyed the navigation. In the year 1540 attempts were made, and much money was spent in endeavours to restore the navigation, but these attempts, it would seem, failed, for in the year 1563 the matter was taken in hand by the Mayor, bailiffs, and commonalty of Exeter, generally termed "The Chamber," in the same manner as the "Mayor, Aldermen, and citizens," the present governing body, are termed the "Town Council." They engaged an engineer of the name of John Trew, and consulted him on the best means of restoring the navigation. He very wisely determined not to waste money in works on the river itself, but to attain the object by means of a canal, similar in all essential points to canals of the present day. It appears that Trew intended at first to construct his canal on the eastern side of the river, by converting an existing leat supplying water to the "Weir Mills," from the river above St. James's Weir, into a canal by placing a lock with two pair of sluice-gates at its lower end. By this means he proposed to bring vessels above St. James's Weir, which was at this time the only obstruction in the river, and from thence they were to have reached Exeter by the river itself. After careful investigations Trew determined to construct his canal on the western side of the river, and to abandon the idea of converting the mill-leat into a canal. He had good engineering

and financial reasons for this change in his project; heavy compensation would have to be paid to the owner of "Weir Mills;" and even if this shallow leat could have been converted into a canal, vessels would have experienced great difficulty in stemming the current from St. James's Weir to Exeter, which was in those days excessively rapid, and, owing to the high ground on this side of the river, it would have been most costly and difficult to extend the canal nearer to Exeter. Trew, therefore, constructed his canal on the western side of the river, in the line shown on the plan accompanying this paper. He constructed the weir across the river Exe, which is still called "Trew's Weir." He stayed the rapidity of the current, raised the water to the necessary level, and his canal was commenced. The total length of this canal was about a mile and three quarters. It was constructed on the section shown on the drawing accompanying this paper. It was 16 feet in width, and only 3 feet in depth, with three pools or locks, about 23 feet wide, and nearly 200 feet in length; they were fitted with sluice-gates, and had a lift of about 2 feet 6 inches of water; in fact, although of ridiculously large size, as compared with our modern knowledge of locks, they were "Pound Locks," similar in principle to those now adopted in canals, and they were undoubtedly the first ever constructed in this country. The town of Topsham prior to this time had been the "Portus Salutis" of this city, all goods being there imported and conveyed to Exeter by land. Trew's canal, however, was a failure; it could not be entered at all times of the tide. It was, besides, of too short a length to successfully compete with the roads, and consequently, in the year 1675, it was lengthened to a point nearly opposite Topsham. It was widened to 50 feet, and deepened to 10 feet. These works took twenty-five years to accomplish, during which great financial and engineering difficulties had to be surmounted, and the canal, after all, was but a very imperfect affair; vessels drawing barely 9 feet of water could alone enter it, and that only at a certain level of the tide-water in the river, for at its junction with the tideway there was a sluice with only one pair of gates, pointing inwards, and the sill of this sluice was 4 feet lower than the sill of the lower gates of "Double Lock;" consequently the whole body of water below this lock had to be raised 4 feet to allow vessels to pass, the waste of water being something like 12,000,000 gallons every time a vessel entered the canal; and although the source of supply was the magnificent river Exe,

the loss of time, of water, and the disadvantages generally of this imperfect navigation to an important commercial city like Exeter, may be imagined. But it speaks most favourably for the Chamber of Exeter that the canal, up to the date of the passing of the Canal Act in 1829, had been constructed, extended, and maintained by them out of their private estate.

In the year 1820 Mr. James Green, a Member of the Institution of Civil Engineers, was employed by the Chamber of Exeter to advise them on the question of the canal, and he made several reports on its existing state, and eventually he recommended certain works being carried out, the principal of which were as follows:—To construct a regular lock, with two pair of gates, at King's Arms, the entrance to the canal from the river above Trew's Weir; to deepen the canal throughout to a depth of 12 feet; to strengthen and raise the banks where necessary; to lengthen the canal to Turf, a point about a mile below Topsham, and to construct two locks with proper gates and sluices, &c., at the two entrances of the canal from the tidal river, one at Turf, and the other opposite Topsham. These recommendations were adopted by the Chamber of Exeter, and the works were therefore put in hand. During their progress Mr. Green recommended and carried out several alterations from his original proposals. He constructed the canal of a depth of 15 feet instead of 12 feet, and he put only a single pair of gates instead of a lock, and constructed a basin connected by a cut with the canal on the western side of the river. The existing works as completed by Mr. Green, and which were opened on September 20, 1830, as shown by the rather curious document accompanying this paper, comprise the following:—A canal $5\frac{1}{4}$ miles in length, with an average width of 60 feet, although at one point it is over 200 feet in width, and 15 feet in depth, capable of bringing vessels of 350 tons burden from Turf to Exeter. A pair of sluice-gates at King's Arms which can be closed against a freshet in the river or when any necessity arises to lower the water in the canal. A basin or wet dock with masonry sides, with a total quay frontage of 1900 feet, capable of berthing 50 vessels of 150 tons each. A lock at Topsham 90 feet in length, 25 feet 8 inches in breadth, and with a depth of 12 feet 6 inches of water over the lower sill at ordinary high water; a lock at Turf 128 feet in length, 30 feet in width, and with a depth of 15 feet 6 inches of water over the lower sill at ordinary high water. The canal is crossed by five wooden swing bridges and by one cast-iron

bridge, their span being only 28 feet, which is inconveniently narrow for passing vessels. The positions of most of the bridges being very awkward for navigation, collisions by the vessels with them or the banks are not unfrequent. A plan accompanies this paper showing the existing canal as designed and carried out by Mr. Green. As an engineering work the Exeter Canal has great interest, not only from its early first construction, but also from its peculiar formation; a great portion of it being constructed in embankment over marshes, giving a very treacherous foundation, and Mr. Green must have met and overcome many difficulties. It will be seen by the drawing which accompanies this paper that the lock at Turf is constructed on piles, no solid foundation having been met with, and much obstruction was caused to the progress of the work by sub-water, and from the tides. If the details of this lock, and especially of its foundations, are studied by the Members present, they will, I think, agree with me in saying that great credit is due to Mr. Green for having carried out this work, and the rest of the canal, in so able a manner. In the year 1869 the invert of Turf lock-pit blew up, and the water from the canal rushed through with great velocity and in great bulk. Mr. Charles E. Ware, my predecessor as Surveyor of this city (whom I am pleased to see present, and who will no doubt be kind enough to explain the details of the work), immediately put certain works in hand of a very interesting character, and completely cured the evil. Since then this lock has been in very good repair, with the exception of a settlement of the western wing wall, which took place in the autumn of last year, and which settlement, I trust, I have stopped by means of a wrought-iron strap, 6 inches in width, and $1\frac{1}{2}$ inch in thickness, chased into and cemented round the wing wall, with three cross-pieces to distribute the pressure, all tied back by three iron rods to an anchor of cross-pieces of oak, firmly bedded in solid ground. This work can be better explained on the spot to the Members who intend to proceed to Turf. The gutway, or entrance from the estuary of the Exe to Turf lock, is constantly silting up, and is an annual expense and trouble. Dredging has to be done at frequent intervals to maintain a sufficient depth of water for vessels to enter the canal, and during the last five years 6176 tons of material have been dredged up at this point, costing over 300*l*. The material removed is deposited in the neighbourhood of Turf House, piles having been driven with slabs fastened to them, so that a consider-

able quantity of land has thus been formed. The soil is extremely fertile, and grows excellent root crops. The dredging is done by manual labour, with the ordinary spoon-bag and crab apparatus. The cost of the material thus dredged up and disposed of, including wheeling a distance of 45 yards, is $9\frac{1}{2}d.$ per ton. In 1873 it cost $8d.$ per ton, but the distance for wheeling was not more than 20 yards. These prices do not include any percentage for depreciation of machinery, plant, or dredge-barge. The present financial position of the canal is not good, railway competition having greatly interfered with its trade. In the year 1842 the canal dues amounted to 7128*l.* In 1843 these dues, together with the town dues, were let for 9905*l.* per annum. Since then the revenue of canals has been so influenced by the introduction of railways, that last year the total revenue of the canal from all sources was only 2562*l.* The cost of maintaining the canal, the basin, and works generally, amounts annually to about 2000*l.* A small income is derived from the sale of osiers, which are planted on some portions of the banks, the roots of which tend materially to assist in binding and strengthening them.

If the financial position of the Exeter Canal was better than it is at present, I should have no hesitation in recommending the Town Council to carry out the following works, which would, in my opinion, greatly improve the canal:—(1) To construct a regular pound lock at King's Arms, with a double set of sluice-gates, so that vessels could enter or leave the canal when the water in the river is at flood levels, which at present cannot of course be done. (2) To reconstruct the wooden swing bridges over the canal, giving them a greater span, and thus making a wider waterway for vessels to pass through. (3) To remove the existing cast-iron swing bridge at Countess Weir, which is clumsy, badly balanced, and difficult to move, and to substitute a light, wrought-iron bridge, to be opened and closed by hydraulic means, the water in the canal giving a ready means of power. (4) To reconstruct both the upper and lower gates at Double Locks. (5) To re-arrange the gutway at Turf, and to erect a wall on the western side, so as to prevent the continual slipping of the mud-bank on that side and consequent filling up of the channel. The towing on the canal is now done by horses, and the question has often been mooted if great benefit would not be gained if the towing were done by steam tugs. I am, myself, afraid of the effect on the canal banks, the towing-path in many

places being only about 1 foot 6 inches higher than the level of the water in the canal. I am also of opinion that there would be great difficulty experienced by a tug in towing a large vessel in the exposed portions of the canal—that the tug and vessel would be blown, in the event of a high wind, on to the lee bank, and there remain. The narrowness also of the passage at the bridges and other points along the canal makes it even now difficult for vessels to steer through without damage to the banks. For these and other reasons I am averse to the introduction of steam-tug towing on the Exeter Canal; but I shall be very glad if, after or during our inspection of it to-day, any Members will give me their opinion on this question or on any of the other matters I have mentioned in this paper.

The document mentioned in the paper is a framed record, preserved in the municipal archives, of the names of the Chamber of Exeter at the "Opening of the New Wet Dock," in 1830. Mr. Boulnois also exhibited plans of the canal in its various stages, and a drawing of the lock at Turf. He observed that the construction of the canal as it at present exists did Mr. Green a great deal of credit, considering the treacherous foundations upon marsh land, and that he did not have the appliances at the disposal of more modern engineers.

Mr. WARE described the successful means which he adopted, as City Surveyor of Exeter, to stop the serious leakage of the canal, the works being executed between July, 1868, and March, 1869, during which time the canal was closed. The leakage was caused by the blowing up of the invert at the Turf lock, and so great was the waste of water from the canal, that the mill-owners at Trew's Weir and Countess Weir paper-mills threatened the Council with an action, in consequence of the great loss of water, which went down the canal instead of into the mill-streams. The first thing he did was to put down stop planks, and to make the place water-tight by mud banks. When this dam was pumped out it was found that the water was rushing away under the invert of the lock in a stream 2 feet in diameter. He found that he should not be thoroughly able to carry out the repairs that were necessary without extending the works back to a place where he constructed a coffer-dam right across the canal, and having done that, he found that the sheet piling was only about 3 feet deep, showing that the contractors in Mr. Green's time were as much up to scamping their work as they are now. The consequence was that the water had

been rushing down under the piling, and the piles could be counted like the pillars in the nave of a cathedral! He removed the defective piling, put down new sheet piling throughout the length of both wing walls, and constructed an apron over the entire area. The effect of this has been to make the lock water-tight; the work was effectual, and we have no waste of water now. Mr. Boulnois will tell you that it was a very effectual work.

Mr. BOULNOIS: Most effectual.

On the suggestion of the PRESIDENT it was agreed to defer any discussion until after the Members had seen the canal works.

The Members next proceeded on a visit to the works connected with the canal, the City Council having placed their barge at Mr. Boulnois' disposal for a trip to Turf, the entrance to the canal from the estuary of the Exe. On the journey Mr. BOULNOIS described the various works. At Turf luncheon was provided. After luncheon, the toast of "The Queen" having been honoured, the PRESIDENT proposed "The Health of Mr. Boulnois, the worthy Hon. Secretary of the District."

Mr. BOULNOIS, in reply, said that his duties had afforded him much pleasure. He would arrange that the next District Meeting should be held at Taunton, where Mr. Smith had a great deal to show them in sewerage work; then at Torquay, where some very large main drainage works had lately been carried out under Mr. Little, who had hoped to have been present on this occasion; then he proposed to call a Meeting at Plymouth, and perhaps that would be followed by a Meeting at some other town in the district. He desired the gentlemen present to ask the Surveyors in their districts to join the Association, as he should be very glad to enrol any gentlemen who were eligible to become Members, and would communicate their names to Mr. C. Jones, the Hon. Secretary of the Association. He then proposed, "The Health of the President." Mr. Ashmead had been President for the current year, and every Member present was personally acquainted with him. As an Association they were four years old, and Mr. Ashmead was the fourth President, and he (Mr. Boulnois) could say for himself personally, from his knowledge of Mr. Ashmead, that no one was more able to be the President of an Association of this kind. He could have hoped that Mr. Ashmead might be the President for another year, but the rules did not permit it. The Annual Meeting last year—a most important meeting—was held at Bristol, of which place Mr. Ashmead was the Surveyor, and a paper was read by him on the Drainage of Bristol, a paper of the greatest interest to

the Members of the Association. He trusted that at some future time Mr. Ashmead might again reign over them as their President.

The PRESIDENT having acknowledged the very kind manner in which the toast of his health had been received, expressed his hope that they would all endeavour to attend the Annual Meeting at Liverpool and support the incoming President, whoever he might be. He had been so well supported on all hands by everyone connected with the Association that he should be happy, did the rules permit, to take office again, but many gentlemen, who had not yet passed that post, would have to come into office before him.

THE MODEL BYE-LAWS FOR NEW STREETS AND BUILDINGS

The Model Bye-Laws for the Regulation of New Streets and Buildings, recently issued by the Local Government Board, were then discussed.

Mr. BOULNOIS read the subjoined letter :—

“BOROUGH SURVEYOR'S OFFICE, TOWN HALL, BRADFORD,
“8th June, 1878.

“Dear Sir,—I am sorry I cannot make it convenient to be present with you on the 21st. Whatever discussion takes place on the Model Bye-Laws in respect to new streets, I hope your Meeting will take a liberal view as to widths.

“I think the Model Bye-Laws are defective in fixing the minimum width so very low as 36 feet, and allowing buildings to be brought forward to the line of street.

“In Bradford we pass no street under 16 yards; and if over 300 yards in length, we insist on 18 and even 20 yards wide.

“Land, as a rule, where new streets are being formed, is moderately cheap, and these wide streets will eventually become the arteries whereby currents of fresh air will be conveyed to the centres of crowded thoroughfares.

“Yours truly,

“JOHN ALLISSON.

“H. P. BOULNOIS, Esq.,
“City Surveyor's Office, Exeter.”

Mr. BOULNOIS next read the following "Notes on the Model Bye-Laws," by Mr. E. B. ELLICE-CLARK.

The writer does not intend to criticize in detail the Model Bye-Laws; that has been amply done already by this Association and the Liverpool Architectural Association, and the Institute of British Architects. It may not be out of place to say that the opinion of the majority of borough surveyors is that the Bye-Laws are generally too stringent and impracticable. The Liverpool Architectural Association have published a report in detail, which summed up is in direct opposition to the Bye-Laws, and suggests their withdrawal altogether. The discussion at the recent conference of the Institute went somewhat in favour of the Bye-Laws, but if that discussion is analysed, it can be shown that those who advocated a General Building Act formed on the Model Bye-Laws are ignorant of the whole of the circumstances local authorities have to deal with, and at the proper time and place the writer will do this. In considering the scope of the Model Bye-Laws, attention is directed to the following points:—

Is it desirable to have Bye-Laws for the purpose of carrying out the intention of the Public Health Act, or would a general statute be preferable?

If the former, do the Model Bye-Laws embrace the best practicable means of doing so?

If not, what is the best means?

Does the Public Health Act provide the machinery for enforcing strict hygienic laws in advance of the people's intelligence?

The first question has of late been frequently discussed by the professional societies named, with a great diversity of opinion. It would appear that a majority of those who practise in the Metropolis and large towns adjacent are in favour of a general Building Act, while those who are engaged in the provinces are adverse to an Act. There are many serious objections to a uniform law for the entire country, which in the writer's opinion are fatal ones. The advantages appear to be more theoretical than practical; indeed, the sole advantage—no doubt a great one, as matters stand—being the substitution of a compulsory statute law for what is now too frequently a permissive Bye-Law; but Bye-Laws may be made to accomplish much more for each locality than a general law, if the making of the former be compulsory instead of permissive. Many urban authorities, as well as portions of areas under rural authorities which require it, at present have no bye-laws for streets and

buildings; this is a mistake, if a town or an aggregation of dwellings is deemed of sufficient importance to have urban powers, it follows that laws for the various purposes of municipal government are necessary, therefore the wording of the Act should be absolute in compelling all existing urban authorities and rural authorities governing areas such as are practically towns, and all newly constituted urban authorities, to make Bye-Laws within one year. This would remove one objection to Bye-Laws.

In a general statute the difficulty appears to give that elasticity in the wording and the discretion to local authorities which the circumstances demand: climatic influences, physical position, character and occupation of inhabitants, nature of building materials, all have a great influence on the execution of works and the ministerial action of local authorities. If proof be needed of this, take the question of refuse removal. In mining communities, say in Durham, Lancashire, and Yorkshire, water carriage for sewage has proved to be impracticable, owing to the character of the population and the difficulties in disposing of liquid refuse, and a general Act would not go so far as to preclude the use of privies and tubs.

In Hove, where the writer is located,* people would be shocked at the idea of the Sanitary Authority permitting any of the intermittent dry systems, and public opinion would speedily put an end to them; in the mining community people would ridicule the idea of being compelled to use water-closets, and would not as we know; so elastic or far-reaching must be a general Act as to include these extremes. So far as this particular matter goes, an Act would be useless, we do that without it which we do with it. Then in building, probably a uniform standard of thicknesses for walls might be adopted, though it is doubtful if this is desirable, but the same cannot be said of the materials of which walls are constructed in Hove and Brighton. Rubble walling, composed of brickbats, flints, and mortar, gauged with fine shingle, is largely used, and owing to the nature of the lime and shingle makes a very good wall. In a district where the lime is not equally good, and the fine shingle unattainable, this kind of wall is never seen, just as in Hove a stone wall is never seen; it is necessary to lay down strict rules for persons building with rubble, a general statute must contain the necessary restrictions for rubble and all other

* Hove is cited, being a town increasing at the rate of 20,000*l.* rateable value per annum.

kinds of walling, and would soon become an enormous volume if embracing the details now dealt with in Bye-Laws; these details are readily grasped in each locality and provided for, superfluous matter is left out. In Hove we do not want to mention stone, we cannot get it; in other districts Bye-Laws do not specify for rubble walling, the buildings never see it.

It will be, indeed has been, urged, that as there is a Building Act for London, why not have one for the entire country? The answer to this is, Permit provincial architects, municipal engineers, and the better-informed local authorities, to read the London Act and ask their opinions whether such an Act could be applied successfully in all the provincial towns and districts having urban powers. The London building community has been used to restrictions since the Great Fire of 1666, so that for two centuries there has been a process of education going on; capitalists and householders are therefore educated up to the standard of the Building Act, and comply with its clauses just as we comply with the usages of the society in which we have lived from our infancy. It may be mentioned that notwithstanding the Act in the metropolis for regulating buildings, as bad construction is seen there as in any other town in England, even in those towns where the Bye-Laws are notoriously lax. The writer, in addressing the conference of architects a few weeks ago, said that every community in the kingdom was not educated up to the standard which would enable the Model Bye-Laws being enforced without coercion, therefore they could not be successfully carried out. Mr. Roger Smith, a district building surveyor in London, said that was the great argument in favour of a compulsory Act, it would compel persons to observe the law, but like many others who argue this way, he forgot the character of the English people in this kind of matter, so admirably summed up in a paper read by Dr. Acland before the Association of Municipal Engineers,* when speaking of this very subject, "The true policy for securing the national health lies in the steady education of the people, to take a thorough and intelligent interest in perfecting, under local management and central or imperial advice and supervision, their local sanitary arrangements, coercion, even if attempted, will in the end retard progress. Theorists may dislike the political truth, that in this country neither the Government nor the people separately from each other direct public opinion or make public law, it is discussion

* 'Proceedings of the Association of Municipal Engineers,' p. 166, vol. iii.

and action and reaction between the two which bring about among us stable progress. Practical life in England does not rest on logical science." The writer asks the leading members of sanitary authorities and borough surveyors whether the Model Bye-Laws could be carried out without coercion? There are many and grievous errors in these models, but admitting them to be perfect, for argument's sake, would they bear the test of application to every urban district in England? No doubt there are many communities to whom some of the laws would be no novelty—though there are some, novelty itself. To again cite Hove: where the Model Bye-Laws are of any value the Hove bye-laws are very similar and equally strict; and there is not more than ordinary difficulty in their enforcement, the reason being that most of the builders have been used to the restrictions of the Metropolitan Act; nearly all the property is of a high-class kind, and the houses are built much better than any law requires, that the executive have so far successfully used the discretionary powers given under the bye-laws, that the governing body is drawn from the educated classes, and that public opinion demands the strictest supervision of sanitary works; but this is exceptional.

The necessary knowledge to enable strict hygienic laws being enforced has advanced very considerably within the past quarter of a century, but not sufficiently in a majority of cases without coercion.

If the Model Bye-Laws are to be embraced in an Act of Parliament, some fresh machinery must be created to give such Act effect; the present executive are unprotected and underpaid; existing sanitary authorities are elected, very properly, by a popular suffrage, and would not everywhere attempt coercion; if they did, the next election would see their seats occupied by new members probably pledged to thwart the intentions of the Act, and each succeeding November would see men returned in the same interest, therefore other provision would have to be provided to enforce a strict law; neither local authorities nor officers as at present elected could do it.

The fact is, no general Act or bye-laws will secure the execution of health works by private owners, while the community electing the authority remains ignorant; only the gradual but "steady education of the people" will accomplish this. In those towns where no restrictive laws have been in force, health laws must not be too onerous, and the standard must be graduated according to the intelligence in these matters of the community, sound public

opinion cannot be raised at a jump to the high level of immediate compliance with strict laws, which we know are so necessary for the conservation of health in crowded areas, it must be first created and then tutored. This can be accomplished by such societies as the Sanitary Institute; by the establishment of such local bodies as the Manchester and Salford and Tottenham Sanitary Associations, by the newspaper press, which instead of devoting columns daily to the reports of such cases as the Balham mystery—reports which can only serve to gratify a morbid curiosity, could bring about incalculable good by publishing articles on questions of health, and fully reporting meetings in connection with sanitary science, by permitting the teaching of the elements of sanitation to take its place with geography and grammar in every school, by establishing professorships of public hygiene at hospitals, universities, and public schools. Once let a community understand it is needful to place certain and defined restrictions on buildings and other sanitary works, and the application of what are now too strict laws will be effected without difficulty, and to this end members and officials of sanitary authorities should strive by disseminating sanitary knowledge amongst the people. The writer's conclusions are, Bye-Laws are more practicable for sanitary purposes than a general Act could be. The Model Bye-Laws contain many errors and require revision. Every sanitary authority should consult the medical, engineering, and architectural professions in their respective districts before they make bye-laws. The Government should take up the question of educating children attending Board schools in the elements of sanitary science.

The PRESIDENT: The latter conclusions are about the best of the paper. I agree with these, but not with the paper itself.

Mr. BOULNOIS: I cannot agree with all that Mr. Ellice-Clark says in his paper. In the first place, it seems to me that it is not so much the education of the masses we want, but the education of the builder, who requires educating up to the Bye-Laws. Mr. Clark mentions errors in the Model Bye-Laws, but he does not state what those errors are. There are many points which require explanation. I may mention, as one point, that the thickness of walls engaged my attention in reading these Bye-Laws, and I found it necessary to address a letter to the Secretary of the Local Government Board, John Lambert, Esq., with a sketch showing my interpretation of the thickness of walls. This is my letter:—

"EXETER CITY SURVEYOR'S OFFICE,
"February 15th, 1878.

"Model Bye-Laws.

"Dear Sir,—Will you kindly inform me if my interpretation of Clause 19, sec. (g), is correct as shown by the accompanying sketch? I also find there is no clause specifying the level of the ground with respect to footings of walls. Apologizing for troubling you,

"I am, dear Sir,

"Your obedient Servant,

"H. PERCY BOULNOIS.

"JOHN LAMBERT, Esq.,

"City Surveyor.

"Local Government Board Office, London."

The reply is as follows:—

"LOCAL GOVERNMENT BOARD,
"WHITEHALL, S.W., 28th March, 1878.

"Sir,—I am directed by the Local Government Board to advert to your letter of the 15th ultimo, respecting the interpretation of Clause 19, section (g), of the series of Model Bye-Laws relating to new streets and buildings.

"The Board forward for your information the accompanying copy of a Memorandum, and of the sketch referred to therein, which they have received from their architect upon the subject of your inquiry.

"I am, Sir,

"Your obedient Servant,

"DANBY P. FRY,

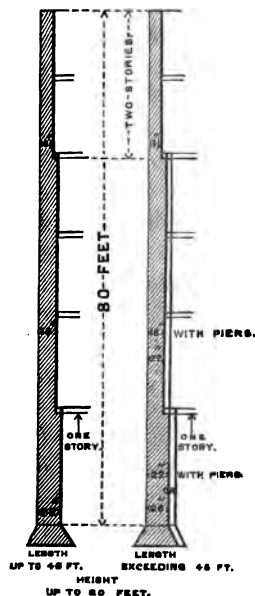
"Assistant Secretary.

"To H. P. BOULNOIS, Esq.,

"Borough Surveyor, Bedford Circus,
Exeter.

"Exeter Borough.

"Mr. Boulnois is certainly not correct in his interpretation of § (g) of Clause 19 of the Model Series IV., for, according to his sketch, the wall would be as much as 40 inches thick in the lowest storey, whereas it is only required to be 22 inches thick in the lowest



storey, 18 inches thick for the height of the next three storeys, and $13\frac{1}{2}$ inches thick for the remainder. In the event of the wall being more than a certain length without the lateral support of return walls, the above required thicknesses below the uppermost two storeys would have to be increased in each storey by $4\frac{1}{2}$ inches; but such extra thickness may, if desired, be confined to piers in the manner described in § (d) of the same Clause 19. Mr. Boulnois will perhaps be able to understand the section better by reference to the annexed sketch.

"I do not understand Mr. Boulnois' difficulty in regard to 'the level of the ground with respect to the footings of walls.' Clauses 15 and 16 of the Model (IV.) provide all that is necessary on the subject of footings of walls."

Having read the clause in full, Mr. Boulnois continued: The point is, that without specifying the height of the different storeys, and giving six storeys in a height of 80 feet, the wall appeared to be of an absurd thickness. It required an explanation, to prevent people going wrong. I wanted to be put right, as I could not understand the meaning of the clause. As to footings, their referring me to those sections is absurd, as there is nothing to show where your footings shall commence. There is another point in Mr. Ellice-Clark's paper which refers to there being no clause in the Model Bye-Laws to allow the rubble concrete walls they have at Hove; but there is a provision for walls of "other hard and incombustible materials." Mr. Ellice-Clark is therefore wrong. It is unnecessary to specify every class of wall. Clause 11 provides that "Every person who shall erect a new building shall cause such building to be enclosed with walls constructed of good bricks, stone, or other hard and incombustible materials, properly bonded and solidly put together." It means almost anything, concrete walls or anything of that kind.

Mr. SMITH: We have adopted the Model Bye-Laws at Taunton with very few alterations. As to the site of every house being covered with "a layer of good cement concrete, rammed solid, at least 6 inches thick," it is left entirely with the Surveyor to say whether it is necessary that the site should be covered with 6 inches of concrete; and the same with footings. I think there is a damp course that we have to alter slightly.

The PRESIDENT: The difficulty was to find where the course was intended to be placed.

Mr. SMITH (in reply to Mr. Dawson): We have adopted almost

all the Bye-Laws, including the building Bye-Laws, because on some previous occasions the Council found a difficulty in securing convictions, on account of what solicitors called *ultra vires*, and it was thought that if we went into Court with the Government Bye-Laws at our back, there would be more chance of enforcing them.

Mr. DAWSON: We have taken our Bye-Laws from Bristol. Our width of streets is 30 feet. But in many parts of the Bye-Laws we modify them, and do not carry them out in their entirety. Take, for instance, the wall going through the roof; if one house stands higher than another, we do not enforce that Bye-Law. Our own Bye-Laws are exactly like yours, all 9-inch party walls. In my district these Model Bye-Laws will come under discussion.

Mr. SMITH: Carrying out the party-walls through the roof is very much disliked. It is only important in the event of fire. At Taunton it is said that we have not fires enough; and if we have one, it is easily extinguished, we have such a power of water.

Mr. DAWSON: Take the common saddle roofs, would you carry the wall through them?

Mr. SMITH: No.

Mr. DAWSON: Take the double gutter?

Mr. SMITH: No.

Mr. DAWSON: In the case of the V and double gutter?

Mr. SMITH: There they make a mess of it.

Mr. BOULNOIS: In reference to the Bye-Law in regard to carrying up the wall through the roof, it is provided that "Every person who shall erect a new building shall cause every wall of such building, when carried up above any roof, flat, or gutter, so as to form a parapet, to be properly coped or otherwise protected, in order to prevent water from running down the sides of such parapet, or soaking into any wall." It is all very well to say that, but the difficulty is to do it; and the walls carried up through the roofs have a tendency to cause damp.

The PRESIDENT: In Bristol we do not think of adopting the Model Bye-Laws. We have local Acts which are quite sufficient for our purpose, and therefore we have no intention at present of introducing the Model Bye-Laws. At Dartford the question of fees was considered. At Bristol we have fees which produce about 700*l.* a year, but if the Model Bye-Laws were introduced, there would be no fees.

Mr. DAWSON: And extra supervision would be required.

Mr. BOULNOIS: If these Model Bye-Laws are carried out, it means

the cost of a clerk of the works on every building that is going on, to be paid for by the Local Authority.

MR. DAWSON: It should certainly not be paid out of the rates.

THE PRESIDENT: The question is, whether this should not be provided by the Local Government Board.

MR. BOULNOIS produced the Exeter Bye-Laws as to New Streets, Buildings, &c., confirmed in 1871, after which the party adjourned.

THE APPLICATION OF STEAM ON THE EXETER CANAL.

On the return trip to Exeter Mr. BOULNOIS invited discussion upon his paper on the Exeter Canal, and asked the opinion of the Members on the question of the applicability of steam-tug towing on the canal.

THE PRESIDENT: It has been tried on other canals with banks as low as those of this canal, and found to work very well.

MR. SMITH: On the Regent's Canal it has been done, and there is no danger to the banks, but the walls are of stone to 4 feet beneath the surface.

MR. GALSORTHY: I do not think the wash would hurt these banks at all.

MR. SMITH: There is very little wash with a twin screw. Captain Beadon's twin screws are in the bows of the vessel.

MR. PRICE: There is one peculiarity about this canal—the banks are built up, and not excavated.

MR. DAWSON: Is it thought that the canal will ever be made a paying concern?

MR. BOULNOIS: It will not be a paying concern very well unless we can get an export trade, and then it might pay fairly well.

MR. DAWSON: But you have a surplus of 500*l*.

MR. BOULNOIS: But that is only as regards the surplus of revenue above the bare cost of maintenance.

MR. WARE: I have always been opposed to the use of steam on this canal, as it has occurred to me that probably the action of the screw would scoop out the sides of the banks under water, and mischief would go on without our knowing it.

THE PRESIDENT: Looking at the width of the canal, down here especially, I do not see that the action of the screw would be detrimental.

Mr. BOULNOIS: In addition to the danger to which Mr. Ware has referred, I doubt whether, as the canal is so short, it would be worth while to try steam upon it, so very little would be saved. The vessels using the canal are generally from 150 to 200 tons. The regulations of the canal are like the laws of the Medes and Persians. A vessel is not allowed to put up her sails, she must be towed up. She must not go more than 5 miles an hour, and the gain of steam in the short channel would not compensate for the risk. A vessel is not allowed to steam up. The 'Ossian,' for instance, which trades between Exeter and Bordeaux, is always towed up. The osiers on the banks produce about 300 bundles at from 2s. to 2s. 6d. a bundle.

Mr. HODGE: It is very little for such a length of bank.

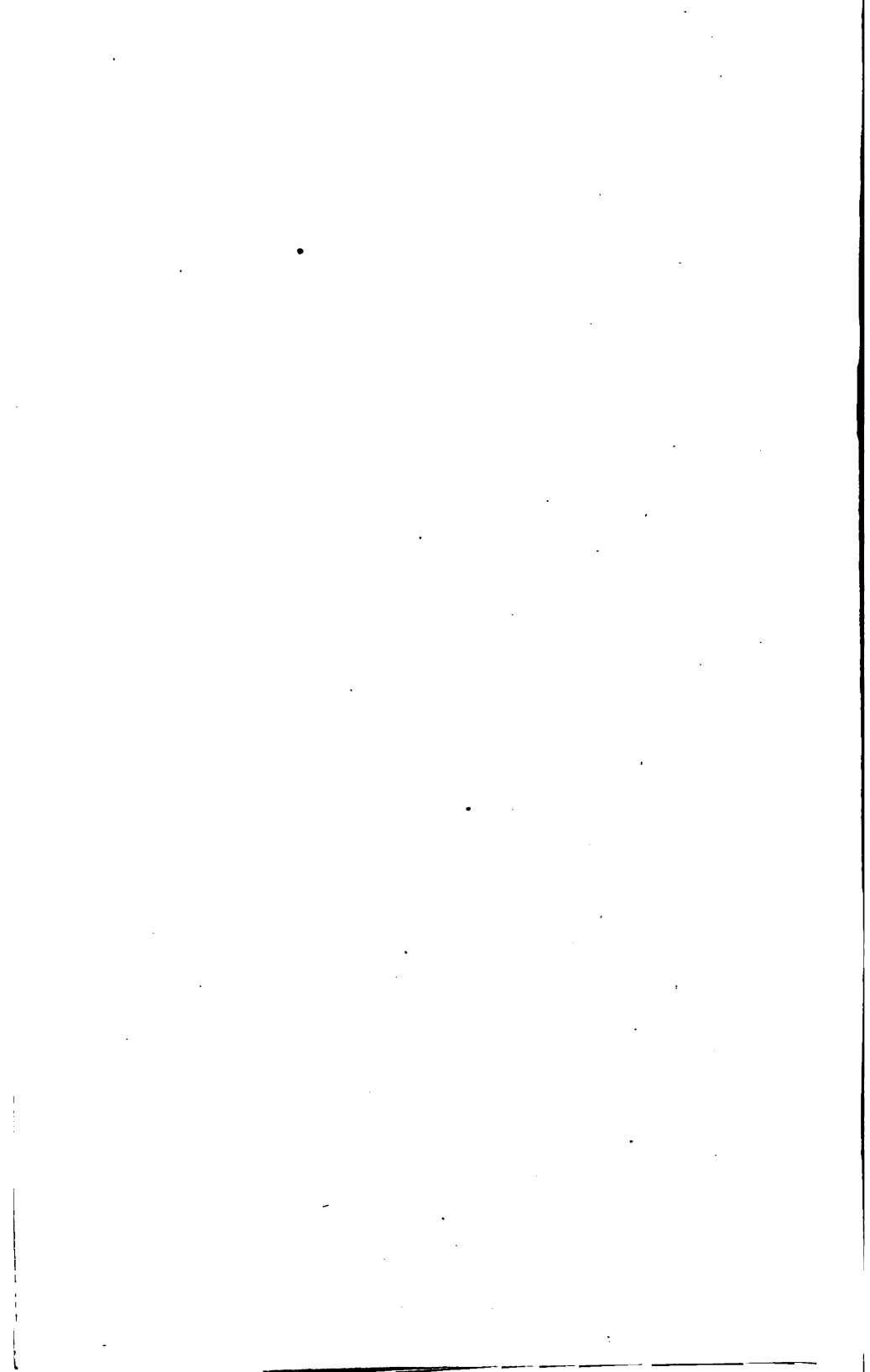
Several Members expressed their concurrence in the views of Mr. Ware and Mr. Boulnois, and the discussion of the subject terminated.

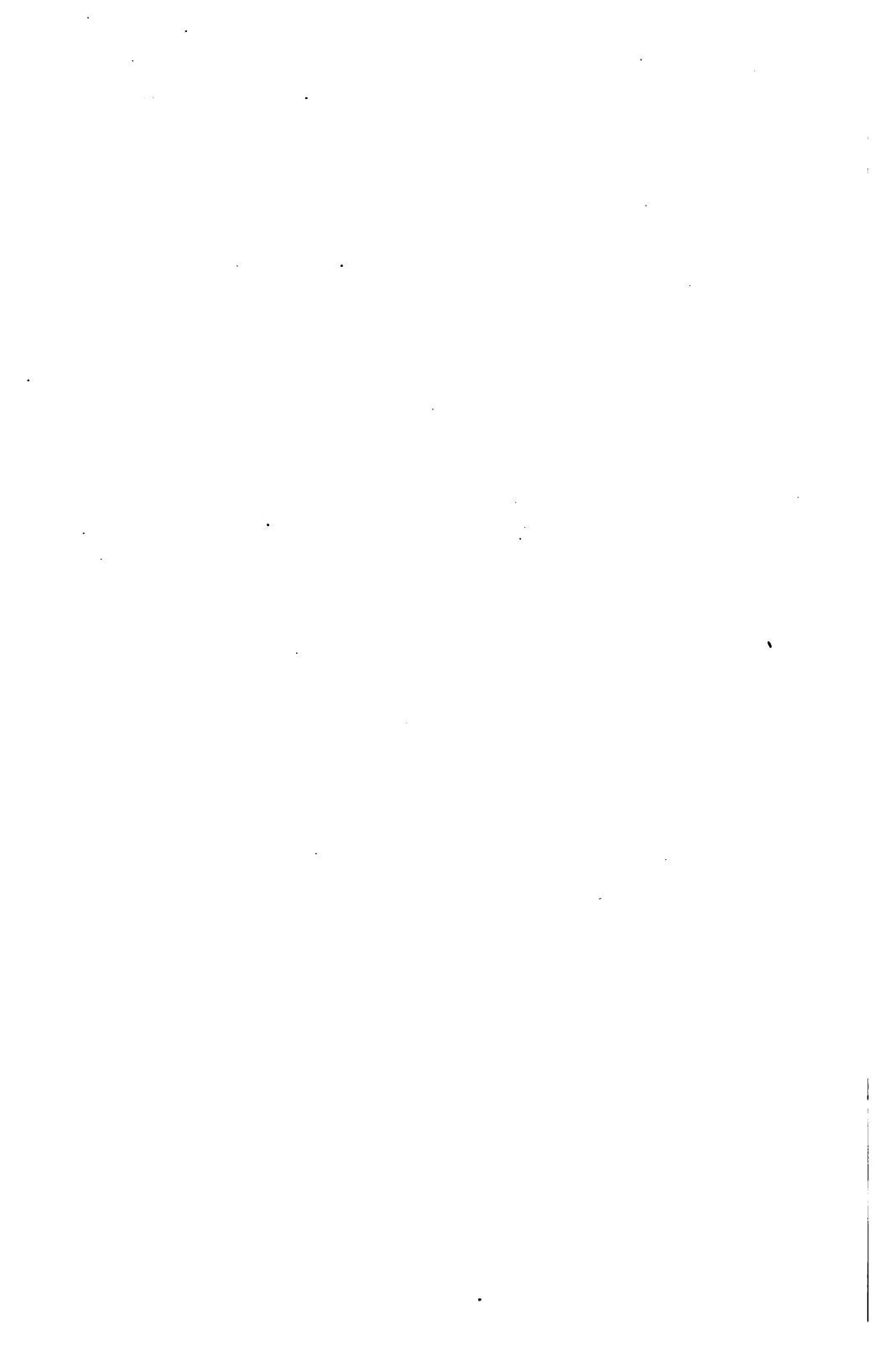
On the return of the Municipal barge to the city, before the party disembarked, upon the proposition of Mr. GALSWORTHY, seconded by Mr. SMITH, the thanks of the Association were accorded to Mr. Boulnois for his interesting paper and his excellent arrangements for the visit to Exeter.

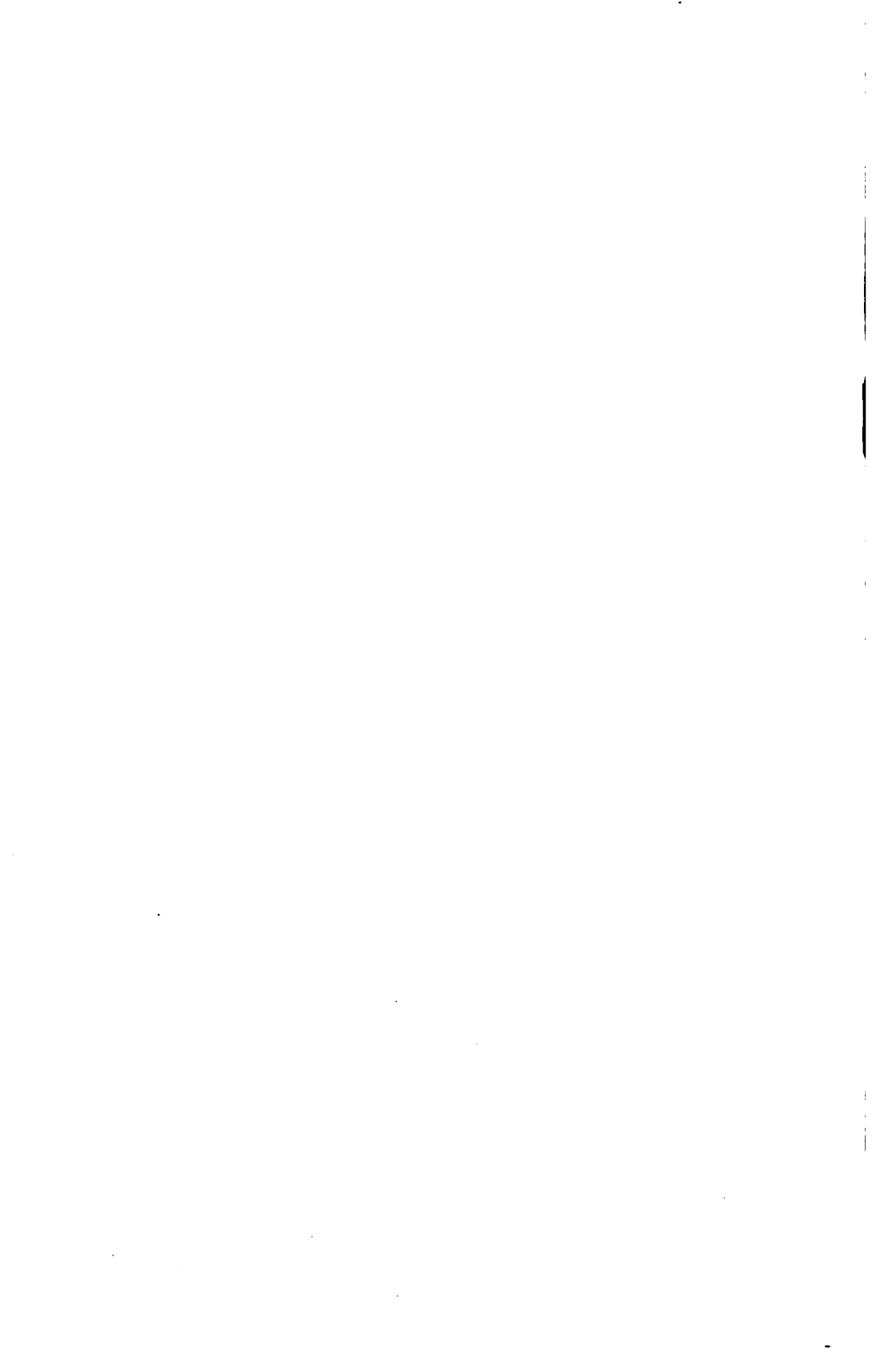


ACADAMIZED ROAD

ing A.	Cost of Watering Streets.	Is House Refuse collected at Public Expense?	What work done by contract.
	£ ..	yes	cept labour in paving.
1	700	yes	ashpits. The team work for removing dirt use from the streets. The team work for ng water on the streets, and the team work ing materials for repairs of streets.
1	100	yes	cept forming paving and flagging of streets.
1	16	yes	ring, forming, ballasting, curbing, and flag- e let by contract. The remainder of work is Corporation workmen.
1	75	yes	ng and drainage works.
1	150	yes	collection and removal.
1	3605	yes	use, ashes, &c.
1		yes	
1	450	yes	path works only let by contract.
1	about 160	no	removal of nightsoil are hired.
1	476	no	
1	..	yes	
1	100	yes	
1	..	yes	
1	153	yes	strict for emptying privies, ashpits, &c.
1	150	no	
1	200	yes	
1	250	yes	of nightsoil to the Carbon Fertilizer Co.
1	124	yes	
1	200	no	
13,000		yes	stone, cartage of soil, and watering.
1	1000	yes	
1	250	yes	ting of house refuse, ashes, &c., removing weepings.
1781		yes	
1	80	yes	d flagging only.
3000		yes	g of streets only.
..		yes	
1562		no	







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